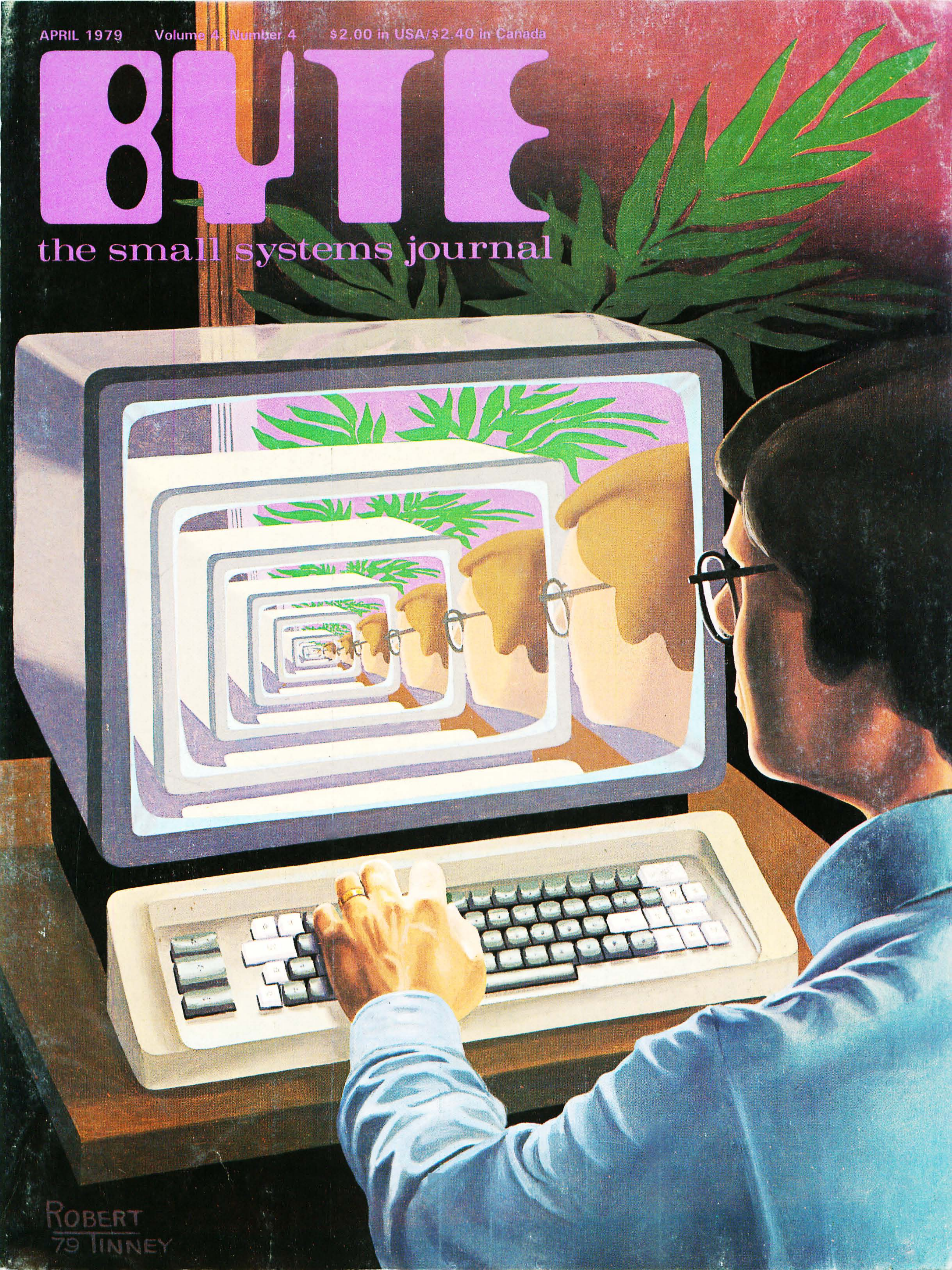
APRIL 1979 Volume 4, Number 4 $2.00 in USA/$2.40 in Canada

BYTE

the small systems journal







Here's how you can be fully computerized for so much less than you thought

BUSINESS — EDUCATION — ENGINEERING — MANUFACTURING

We are pleased to announce the first professional time-sharing system in the microcomputer field.

Naturally, it's from Cromemco.

This new multi-user system will do all of the tasks you usually associate with much more expensive time-sharing computers. Yet it's priced at an almost unbelievably low figure.

Look at these features:

- **You can have up to 7 terminals plus a fast, 132-column line printer**
- **You can have a large system RAM memory that's expandable to ½ megabyte using the Bank Select feature**
- **Each user has an independent bank of RAM**
- **You can have floppy disk storage of up to 1 megabyte**
- **You have confidentiality between most stations**
- **And, make no mistake, the system is fast and powerful. You'll want to try its fast execution time yourself.**



PROGRAMMERS LOVE OUR BASIC

This new system is based on Cromemco's well-known System Three Computer and our new Multi-User BASIC software package.

Programmers tell us that Cromemco Multi-User BASIC is the best in the field. Here are some of its attractions:

- **You can use long variable names and labels up to 31 characters long — names like "material on order" or "calculate speed reduction."**
- **You get many unusual and helpful commands that simplify programs and execution — commands such as PROTECT, LIST VARIABLES, NOLIST, and many more.**
- **No round-off error in financial work (because our BASIC uses binary-coded decimal rather than binary operation). And we've still been able to make it FAST.**
- **Terminals and printer are interrupt-driven — no additional overhead until key is pressed.**
- **The conveniences in this Multi-User BASIC make it much easier to write your own application software.**
- **A line editor simplifies changes.**

BENCHMARK IT — NOW

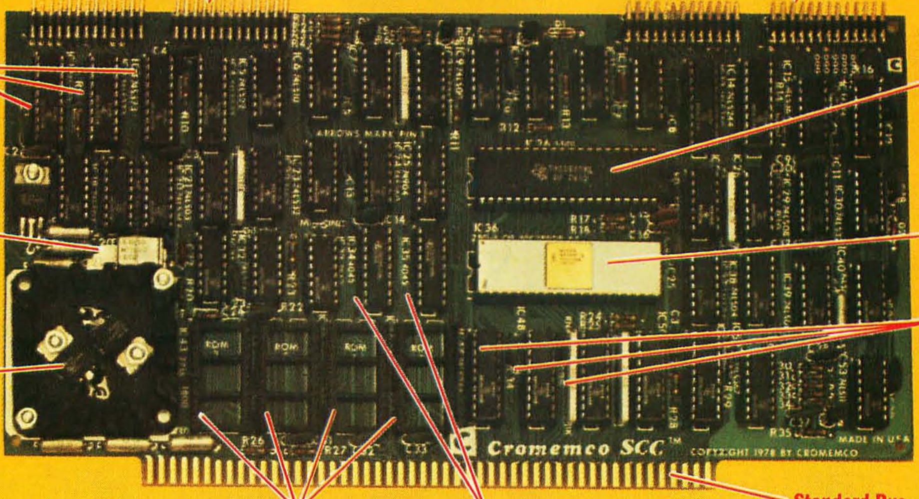
In the final analysis, the thing to do is see this beautiful new system at your dealer. See its rugged professional quality. Evaluate it. Benchmark it for speed with your own routine (you'll be agreeably surprised, we guarantee you).

Find out, too, about Cromemco's reputation for quality and engineering.

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Circle 80 on inquiry card.



The single card computer with the features that help you in real life

COMPLETE COMPUTER

In this advanced card you get a professional quality computer that meets today's engineering needs. And it's one that's complete. It lets you be up and running fast. All you need is a power supply and your ROM software.

The computer itself is super. Fast 4 MHz operation. Capacity for 8K bytes of ROM (uses 2716 PROMs which **can be programmed by our new 32K** BYTESAVER® PROM card). There's also 1K of on-board static RAM. Further, you get straightforward interfacing through an RS-232 serial interface with ultra-fast speed of up to 76,800 baud — software programmable.

Other features include 24 bits of bidirectional parallel I/O and five on-board programmable timers.

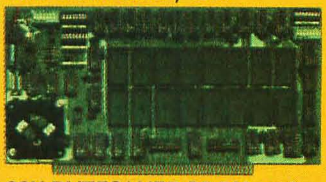
Add to that vectored interrupts.

ENORMOUS EXPANDABILITY

Besides all these features the Cromemco single card computer gives you enormous expandability if you ever need it. And it's easy to expand. First, you can expand with the new Cromemco 32K BYTESAVER PROM card mentioned above. Then there's Cromemco's broad line of S100-bus-compatible memory and I/O interface cards. Cards with features such as relay interface, analog interface, graphics interface, opto-isolator input, and A/D and D/A conversion. RAM and ROM cards, too.



Card Cage



32K BYTESAVER PROM card

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Another convenience that makes the Model SCC computer easy to use is our Z-80 monitor and 3K Control BASIC (in two ROMs). With this optional software you're ready to go. The monitor gives you 12 commands. The BASIC, with 36 commands/functions, will directly access I/O ports and memory locations — and call machine language subroutines.

Finally, to simplify things to the ultimate, we even have convenient card cages. Rugged card cages. They hold cards firmly. No jiggling out of sockets.

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The Cromemco Model SCC is available now at a low price of only $450 factory assembled ($395 kit).

So act today. Get this high-capability computer working for you right away.

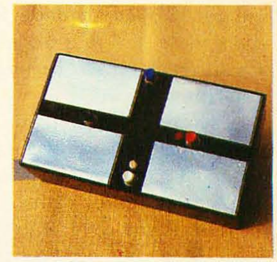
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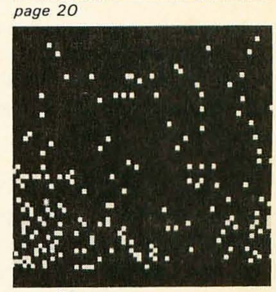
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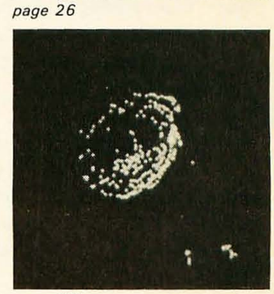
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Background

Nucleus

Cover Art:
INFINITE REGRESSION
by Robert Tinney.

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In this BYTE

This month's cover painting by Robert Tinney is called "Infinite Regression"— an appropriate way to introduce you to several articles in this issue dealing with computer simulation.

The term "simulation" can have a bewildering variety of meanings; we have restricted ourselves herein to simulations of galaxy projections, digital circuits, celestial mechanics, and an ideal two-dimensional gas — all using your personal computer or programmable calculator.

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How to buy a personal computer.

Suddenly everyone is talking about personal computers. Are you ready for one? The best way to find out is to read Apple Computer's "Consumer Guide to Personal Computing." It will answer your unanswered questions and show you how useful and how much fun personal computers can be. And it will help you choose a computer that meets your personal needs.

Who uses personal computers.

Thousands of people have already discovered the Apple computer—businessmen, students, hobbyists. They're using their Apples for financial management, complex problem solving—and just plain fun.

You can use your Apple to analyze the stock market, manage your personal finances, control your home environment, and to invent an unlimited number of sound and action video games. That's just the beginning.

What to look for.

Once you've unlocked the power of the personal computer, you'll be using your Apple in ways you never dreamed of. That's when the capabilities of the computer you buy will really count. You don't want to be limited by the availability of pre-programmed cartridges. You'll want a computer, like Apple, that you can also program yourself. You don't want to settle for a black and white display. You'll want a computer, like Apple, that can turn any color tv into a dazzling array of color graphics.* The more you learn about computers, the more your imagination will demand. So you'll want a computer that can grow with you as your skill and experience with computers grows. Apple's the one.

How to get one.

The quickest way is to get a free copy of the Consumer Guide to Personal Computing. Get yours by calling 800/538-9696. Or by writing us. Then visit your local Apple dealer. We'll give you his name and address when you call.

*Apple II plugs into any standard TV using an inexpensive modulator (not included).



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Circle 15 on inquiry card.

Editorial

On the Importance of Backups

by Carl Helmers

The other day I had a problem using my computer system which many readers may have had. The lesson to be learned from my experience forms the subject of this essay.

This problem is one of zapping the file structure of a disk. Sooner or later everyone who uses a small computer system will encounter a similar situation. One could be tempted to think, naively, that such problems are limited to large computer systems with large sensitive flying head disk media, but this is by no means the case. Floppy disks can be logically zapped just as easily.

I, like many of our readers with systems, have not been letting my system lie idle in the house. In the years since starting this publication with my associates in 1975, I have been suffering withdrawal symptoms from big computers and associated time sharing software. In my case it was everyone's favorite target of criticism, TSO running on a large IBM 360 system. Well, finally small computers got to the point where they could support my style of language, Pascal. Last summer, I bought the Northwest Microcomputer Systems model 85/P with UCSD Pascal as its operating system, filing system, editor and high level language package.

(An aside: at present, the options are hardly limited to the 85/P as many other small computer manufacturers have begun offering versions of this excellent software; at present one can get it on machines ranging from a dual mini-floppy Apple II or North Star Horizon, to machines with full size floppies like my 85/P, or the Cromemco system we are using at BYTE as an editorial computer, to the most exotic of all Pascal machines, the Western Digital "Pascal Micro Engine" which directly executes the p-code intermediate output of the UCSD compiler. Recent word from Apple has it that the UCSD Pascal system *with* full Turtle graphics will be available in June of this year for approximately $400 hardware and software cost. The hardware consists of a special 16 K programmable memory card added to a 48 K Apple II with single or dual disks. The software is the complete UCSD system of editor, file system, Pascal compiler and utilities.)

Recently I have been writing my editorials for BYTE using the excellent screen oriented editor program of the UCSD system. I have been learning Pascal so that I can make it my principal software development tool. I have been learning the details of using Pascal as a significant hardware oriented programming aid, a limited function with the 85/P but one which will blossom to full fruition when I get the Pascal microengine sometime in the coming months.

All this is but a prelude. I have also learned anew the opportunities for making foolish mistakes. One of the most foolish is that of not periodically backing up files against possible losses. The losses I refer to can stem from numerous causes.

We all, quite naturally, assume that the systems software is perfect, but there is that nagging 1 percent of doubt that everyone has. So even if we had perfect media, it would be necessary to back up files by copying from one disk to another as insurance against software failure. But that is hardly the major problem.

Continued on page 196.

"My 8 to 5 minifloppy™ now works nights and weekends."



"I own a fast-growing business and before I bought my computer system I put in a lot of late hours keeping up with my accounting and inventory control. Now the computer does my number crunching quickly, so I have time after hours to have some fun with the system. My son and I started out playing Star Trek on the system, and now we're learning to play chess.

"When I was shopping around for my system, the guys in the computer stores demonstrated all the unique features of the minifloppy. I've got to admit that at first I didn't really understand all the technical details. But now that I use the system every day, I really appreciate the minifloppy's fast random access and data transfer. I like the reliability, too.

"I'm glad I went with Shugart drives. Look, when you lay out your own money for a system, you want dependable performance and good value. Do what I did. Ask for the system with the minifloppy."

If it isn't Shugart, it isn't minifloppy.

Shugart Associates

435 Oakmead Parkway, Sunnyvale, California 94086

For a list of manufacturers featuring Shugart's minifloppy in their systems, circle reader response number.

TM minifloppy is a registered trademark of Shugart Associates

Letters

SUCCESSFUL TRANSFORMATION

I thoroughly enjoyed the article "Fast Fourier Transforms on Your Home Computer," by William D Stanley and Steven J Peterson (December 1978 BYTE, page 14). I have the program running on Radio Shack TRS-80 disk BASIC. I also tried the BASIC code in "Tic-Tac-Toe in BASIC" (December 1978 BYTE, page 174). It would be helpful if Mike Stoddard, the author, had explained the characteristics of his source machine. I spent some time converting the "215" enclosed in backslashes to CHR$ (215) for formatting purposes.

I enjoy your magazine and use it regularly. Keep it up.

Joseph X Brennan
POB 302
Upland CA 91786

*Another problem with "Tic-Tac-Toe in BASIC" was the accidental omission of program lines 2590 through 3080. The missing lines were printed in the "BYTE's Bugs" section of the February 1979 BYTE, page 43. . . .*CH.

MAKING CENTS

Being an avid reader of BYTE I have received many helpful hints about how to use my computer more efficiently. I have enclosed a simple program that puts dollars and cents into business programs.

A lot of small businesses need calculated results in a print out in the form of at least two digits, complete with 0s after the decimal point (eg: "$2.00"). Most systems automatically eliminate trailing 0s. The enclosed program can be used as a subroutine to perform this task. The variable must be made equal to X previous to using the subroutine.

As you can see, the program returns even if there is no need to add 0s. Several small businesses are using this simple answer to the *zero problem.*

```
1000 C=0
1010 LET A$=STR$(X)
1020 LET I=LEN(A$)
1030 LET H=I-1
1040 IF X=INT(X) THEN PRINT
     MID$(A$,1,H); ".00": RETURN
1050 FOR A=1 TO 9
1060 LET B=C+.1
1070 IF X=INT(X)+B THEN PRINT
     MID$(A$,1,H); "0": RETURN
1080 LET C=B
1090 NEXT A
1100 PRINT A$
1110 RETURN
```

James Thebeault, Sr
Rte 12 POB 94
Mansfield OH 44903

DIGICAST DATA

I just read Mr Halsema's article, "The Digicast System: Receiving Data and Information over your FM Radio" (January 1979 BYTE, page 100) and I noted a few technical deficiencies in his description of an FM station's signal spectrum.

Mr Halsema describes the L-R difference signal centered around 38 Khz as the pilot carrier. In actual practice, the station transmits a 19 Khz (±2 Hz) stereo pilot tone at 8 to 10 percent modulation. This is the synchronizing signal used by the receiver in demodulating the L+R and L−R signals into discrete L and R channels.

In FM broadcasting, the 75 Khz deviation Mr Halsema refers to is the 100 percent modulation point. We could get into modulation index and other parameters, but the BYTE letters column is not the place for this. Suffice it to say that "high fidelity music" transmission is not restricted by the current modulation limits.

Two factors that may limit the growth of digicasting in metropolitan areas are present. Assuming that the 67 Khz SCA (Subsidiary Communications Authorization) signal is used for digicasting, the first factor is the "loudness" game that many stations get caught up in in the quest for larger market shares. The 19 Khz pilot eats up 10 percent of the modulation capability. The 67 Khz SCA signal eats up another 10 percent of the modulation capability. This leaves a maximum of 80 percent modulation capability for your main carrier program material. While this is only a 1 db to 2 db decrease in "loudness" compared to a nonSCA or a mono station, there are many programming and time sales people who believe that they need to be the loudest station on the dial. The second factor is that some major market broadcasters subscribe to music syndication services. Some of these services (notably Jim Schulke's SRP service) have been known to write clauses into their contracts that forbid the subscribing station from using an SCA signal.

As a sidenote, two years ago while I was still in broadcast engineering, I was contacted by an outfit called Cables & Wireless Ltd. They were looking for an SCA signal to use for electronic message (or mail) service. My station was under a "no SCA signal" clause with a music syndicator and I had to turn them down, but recently *Computer Decisions* magazine published an article on electronic mail that briefly discussed the Cables & Wireless Ltd system.

I look forward to digicasting with great anticipation but I fear that it will become mired in the infinite jungle of federal regulations.

Noel M Moss
UniCard
1034 S Brentwood Blvd
St Louis MO 63117

Continued on page 206.

BEFORE YOU BUY COMPUTER #1, VISIT #1 COMPUTERLAND

If the truth is that you want a computer . . . then we want to be your computer store.

We're ComputerLand, the #1 computer store chain in the U.S. What's meaningful about that fact is, that ComputerLand has been chosen by more people as having what they've been looking for. And, since you're looking, let us tell you what you'll find, when you visit a ComputerLand store.

You'll find a product line that's continually evaluated to provide you with the widest and best selection in quality, brand name microcomputers anywhere. You'll find an enthusiastic and knowledgeable staff able to interpret all the equipment specifications, in terms of how they apply to you, and in a way you'll understand. You'll find demonstration areas where you can get a firsthand experience of running a computer yourself.

COMPUTERS FOR BUSINESS



You'll find educational materials to give you a total insight into the world of microcomputers.

You'll find a fully equipped service department to provide whatever assistance is required to keep your computer running in top-notch condition. You'll find computer user's clubs to join, where you can share ideas with people as enthusiastic as yourself. And, with each new visit, you'll find excitement—from the people you deal with, the equipment they offer, and from your own ever-growing personal involvement.



Enough about us. How about what computers do. To attempt to describe all the things your computer might do, would be to describe your imagination. So instead, we'll briefly list some of the many things for which small computers are already being used.

In business, the advent of the versatile and compact microcomputer has put the benefits of computing within reach of small companies. With systems starting at less than $6000, the businessman can computerize things like accounting, inventory control, record keeping, word processing and more. The net result is the reduction of administrative overhead and the improvement of efficiency which allows the business to be managed more effectively.

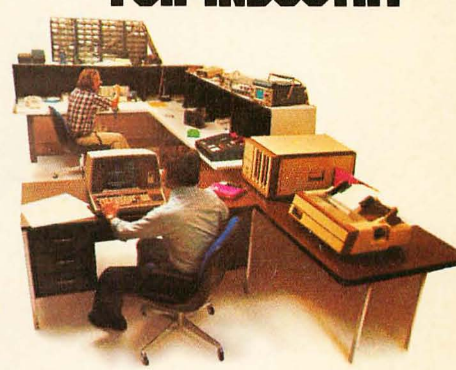
In the home, a computer can be used for personal budgeting, tracking the stock market, evaluating investment opportunities, controlling heating to conserve energy, running security alarm systems, automating the garden's watering, storing recipes, designing challenging games, tutoring the children . . . and the list goes on.

In industry, the basic applications are in engineering development, process control, and scientific and analytical work. Users of microcomputers in industry have found them to be reliable, cost-effective tools which provide computing capability to many who would otherwise have to wait for time on a big computer, or work with no computer at all.

COMPUTERS FOR THE HOME



COMPUTERS FOR INDUSTRY



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The Toy Store Begins at Home

Ciarcia's Circuit Cellar

Simon is a trademark of the Milton Bradley Corporation.

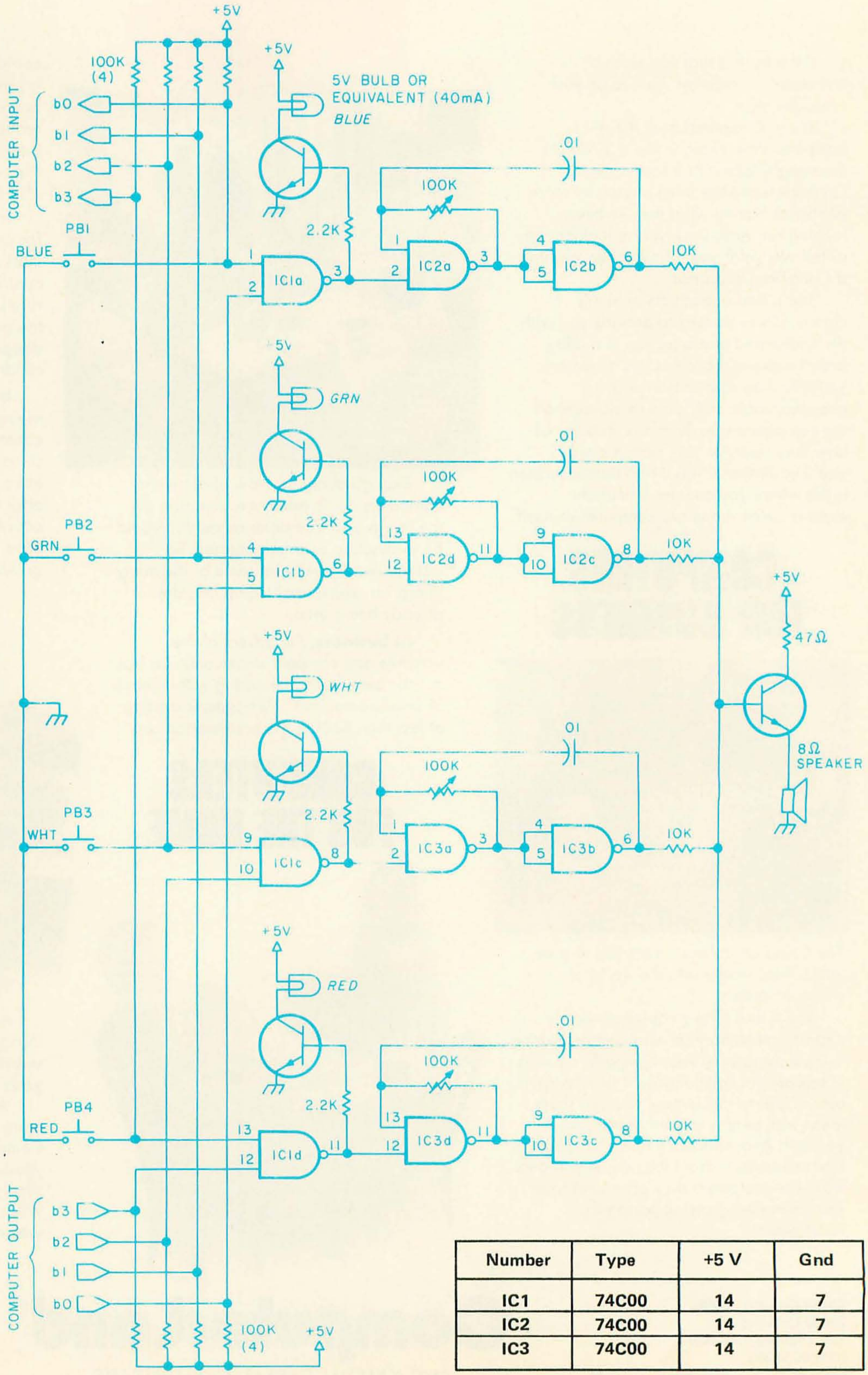
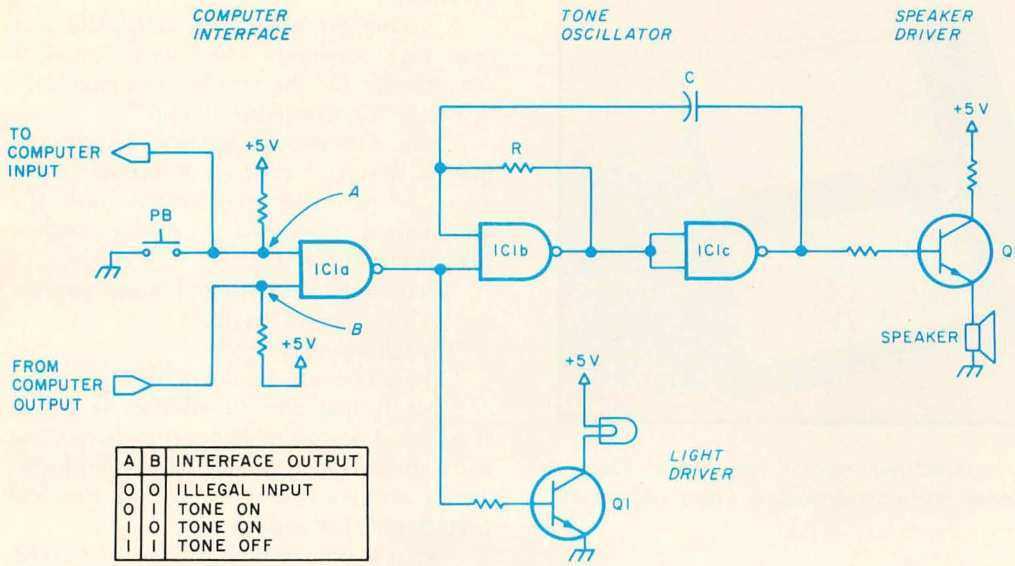


Figure 1a: Hardware tone generator for the musical tone sequencer. The computer plays a sequence of lights and associated tones and detects the player's response. (All transistors are 2N2222.)

Number	Type	+5 V	Gnd
IC1	74C00	14	7
IC2	74C00	14	7
IC3	74C00	14	7



A	B	INTERFACE OUTPUT
0	0	ILLEGAL INPUT
0	1	TONE ON
1	0	TONE ON
1	1	TONE OFF

Figure 1b: Details of the circuit in figure 1a, showing one of the four light and sound generating sections.

Steve Ciarcia
POB 582
Glastonbury CT 06033

"Mister? Mister?"

A little boy was tugging on my sleeve. It startled me that in today's sophisticated society anyone would attempt to attract my attention by such an obvious, though effective, means. Impatient and undaunted by the scowl I flashed in his direction, he said, "Mister? Do you know where the toy department is?"

I have never acquired what some people call the ability to commune with children. Perplexed therefore as to the presentation of a proper reply, I considered an indignant, wave-of-the-hand dismissal of "Over there, kid." On the other hand, should I consider a character reversal with a Santa Claus imitation and invite the young man to hop up on my shoulder while we looked over the store directory together? The latter seemed hardly my style and the former was much too harsh even considering his still firm attachment to my sleeve.

"Mister? Mister?"

The delay only heightened his fervor.

I looked up and found myself staring straight at the shirt pocket button of a very large man. Instantly I calculated that this male figure dressed in jeans, heavy boots and a woolen shirt was a foot taller than I. His relationship with the boy was quickly clarified as he said in a deep paternal voice, "Come on Brucie, I think it's over there where that crowd is." I waited for Paul Bunyan and son to be safely on their way before I made my next move.

Stark reality returned, however, when I remembered that I, too, was looking for the toy department. It verges on humiliation actually. Why do they have to categorize everything? Just because an item is manufactured by a toy company doesn't immediately classify it as a toy. I mean, big people have constructive leisure time manipulatives and little people have toys. Department stores should realize the embarrassment of crossing this line and have an "amusements for the sophisticated" department and a "toys for tots" department.

Finding the toy department was no problem. I simply stood where I was and slowly rotated 360°. The noise peaked at about 160° SSE and I cautiously proceeded in that direction. The noise in my immediate vicinity became sharply amplified as two young boys raced by, carrying some unidentifiable toy devices.

I spied my objective ahead — the electronic games counter. I got into line between two youngsters and their parents. Were these PG or R rated games? I saw no parents with the kids playing basketball in the next aisle. Perhaps the cost of computerized games warranted closer parental scrutiny. $5 for a hockey stick is one thing, but $50 for a talking plastic robot is another. All the games at this counter incorporated microprocessors as their intelligence. Some simulated war games

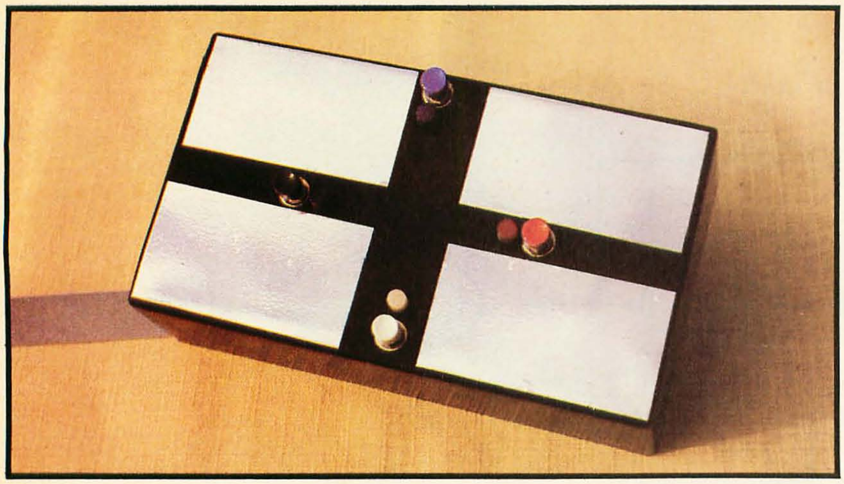


Photo 1: Player console for the computerized musical tone game. Players attempt to repeat a sequence of tones and corresponding lights chosen by the computer at random.

and produced authentic battle sounds while others proved to be formidable challengers in games of chance.

I looked through the products in the case, hoping to spot the one I so desperately wanted. Would this be another store that was completely sold out? Would I never get my Simon?

"Sir? Can I help you?" the salesman asked. His attitude was surprisingly pleasant considering that he worked in the store's combat zone.

"I don't see it!"

"See what, sir?"

Still vaguely pleasant, his tone changed to "I've had a long day, buddy. Let's not play 20 questions."

"Simon of course!" I replied. "But I know you don't have any. No one does."

"You're in luck, sir. I believe we received a back ordered shipment yesterday. I'll check."

A young girl behind me said, "Did you hear that, mommy? They have Simon! I can practice for the competition after all."

I said, "Competition? Simon?"

"Sure. Everybody's got one. Except me, that is. We have contests in school to see who can remember the longest tune. It's fun. Oh, I can't wait!" she responded, tugging on my sleeve.

"That sounds exciting. I hope you do well in the contest," I said.

The salesman returned.

"I have one left. You're in luck."

I hardly had time to smile as he passed it to me. I heard a whimper from behind me and sensed the little girl's disappointment. Saying nothing I turned to look at her. She tried to hide her anguish.

"What is your name, little girl?" I asked, stooping down a bit to be more at her level.

"Brenda," she said wistfully.

"That's a coincidence. I have a little . . . er, girl named Brenda too." I had to catch myself – as I have a female Scottish Terrier named Brenda. Parents might get upset if you compare their children to dogs. "She's a little smaller than you are."

"Is Simon for her, Mister?"

"No, she likes playing with tennis balls. But no matter. I've only been *looking* at this game. I'm not sure I really want to buy it just yet. Would you like it?"

She offered several relieved thank-yous as I bolted for the door. I was in a hurry to get to the department store two blocks up the street before they closed. . . .

Musical Games Are Addicting

Some time ago I was in a stuffy business meeting. When it became apparent to the chairman that most of the attendees were asleep, he pulled out a saucer shaped object with four colored areas on it and slid it along the table. It stopped in front of me and went "beep" and lit a red light. Instructed to respond in kind, I pressed the red area which turned out to be an oversized lighted pushbutton. The saucer replied "beep-boop" and lit the red and green lights sequentially. It became immediately apparent that the plastic saucer was a game and the object was to duplicate the sequential tones it played. The task became increasingly difficult as it added another note each time around. If missed, it made a sound like a "raspberry" before starting a new game.

This "game" turned out to be Simon, from Milton Bradley Corporation. It uses a microprocessor to synthesize the tones, light the lights, and generate the sequence.

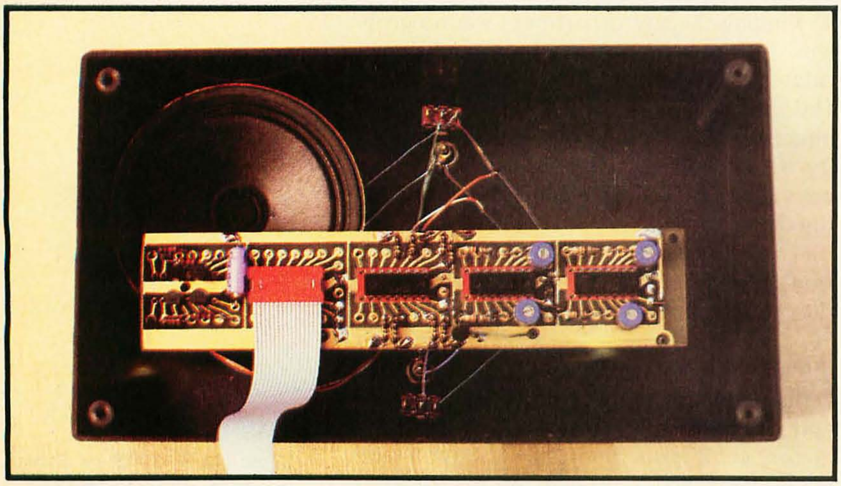


Photo 2: Bottom view of the player's console. The ribbon connector attaches to the user's personal computer.

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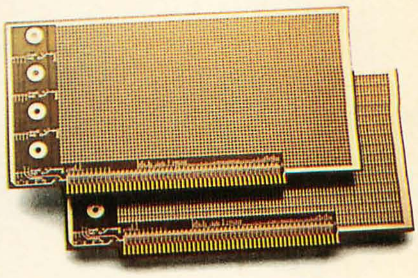


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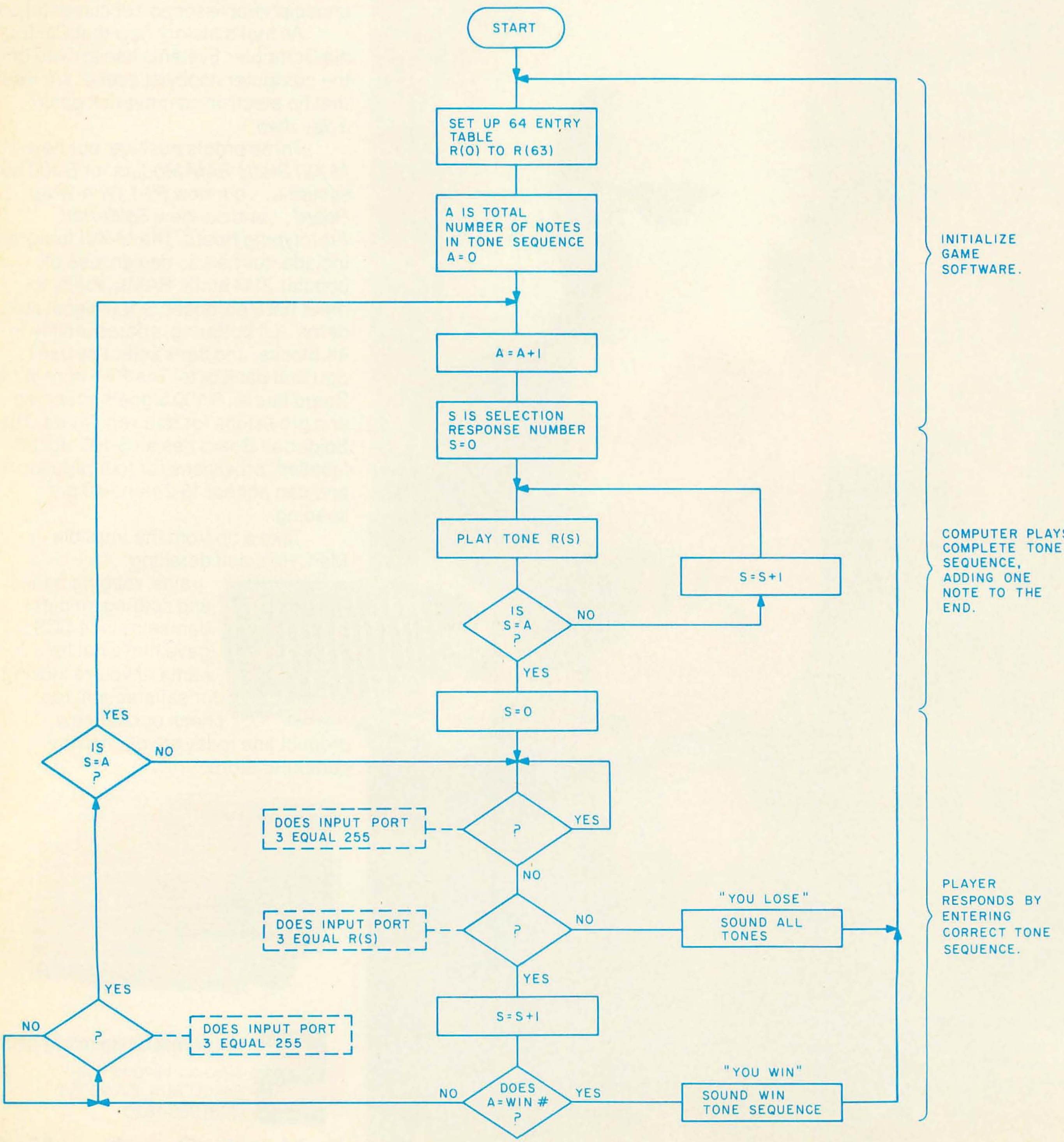
So Nobody Goes Away Mad.

Circle 37 on inquiry card.

Build Your Own Musical Game

It is only logical that any of the $30 to $50 electronic toys in department stores can be simulated with the average $6000 personal computer. (This is why critics frequently call computers illogical.) The distinguishing feature between a toy built around a microprocessor and the average home computer is the packaging and I/O (input/output) interface. With the exception of addressable memory, the microprocessor in a battleship game has a processing capability comparable to the more general purpose processors like the 8080 and 6800. The major difference is that single chip computers incorporate limited quantities of programmable memory, read only memory, and I/O in one package. This is the most cost-effective approach for a dedicated task like a game. The most popular single chip com-

Figure 2: Flowchart for the computerized musical game.




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puter in the computer games market is the Texas Instruments TMS 1000. Customized versions of this integrated circuit are used in the majority of electronic games.

Presuming that we can write a program on our large computer that accomplishes the same logical objective as the dedicated game, the only real difference becomes I/O. Most personal computers incorporate ASCII keyboards, video displays, and tape cassette interfaces for I/O. Electronic board games use a few switch inputs (constant closures) and lights or buzzers for output and, because there is little operating system overhead, sound effects are directly synthesized by program timing loops. Theoretically, if we attach these switches and lights to a convenient I/O port on our computer we should be able to program a similar or even more challenging game.

Building a musical game that tests the players' ability to memorize a string of tones is a simple task. Input to the computer consists of four switches, one for each of four tones. Output from the computer is likewise four signals which light four colored lights on the player console. Each light corresponds to a distinctive tone.

The game is simple to play. The computer plays a tone and the player responds by pressing the button for that same tone. Next, the computer plays two notes and the player replies accordingly. Each correct exchange results in adding one more note to the string. Eventually either the player misses by being unable to replay the exact tone sequence, or wins by attaining some preset number of notes without failure. The former is signified by an ungracious combination of tones and the latter by a distinctive tune played by the computer in celebration.

There are two possible design approaches. One is to use machine language and a "bare bones" interface consisting of four switches and four lights directly connected to a parallel input and output port. Timing loops written into the software produce the tones. This method uses the least hardware but requires considerably more software.

The second alternative is to use a high level language such as BASIC and use an external hardware interface for tone generation. This is the approach I have taken. Experimenters wishing to use another approach can easily follow the logic flow of BASIC and in this way I am not confining the reader to a particular microprocessor. Also, on-the-spot program variations to accommodate individual players are more easily implemented in a high level language.

Photo 3: Corner of the circuit cellar showing the 64 K dual floppy disk Z-80 system used by the author to drive the musical tone game.



Listing 1: Program for the musical tone game, written in 8 K Zapple BASIC.

```
90 REM
92 REM ** CIARCIA'S CIRCUIT CELLAR COPYRIGHT 1979 **
94 REM
100 PRINT"THIS IS A MUSICAL GAME TO TEST YOUR MEMORY"
105 REM
110 REM
115 REM FIRST THING WE DO IS SET UP A TABLE OF 64
120 REM RANDOM NUMBERS WITHIN THE CHOICES OF 1,2,4, OR 8.
125 REM THESE NUMBERS ARE SINGLE BITS WHICH INDICATE A
130 REM PARTICULAR TONE AND COLORED LIGHT.
135 REM THE COMPUTER INTERFACE IS BITS 0 THRU 3 OF I/O PORT 3
140 REM
200 DIM R(64) :DIM S(64) :DIM A(64)
205 A=0
210 FOR S=0 TO 63
220 R=INT(RND(1)*10)
230 IF R>3 THEN 220
240 R(S)=255-2^R :REM THE INPUT TO THE INTERFACE IS LOW TRUE LOGIC
245 REM TO TURN ON A TONE ALL BITS ARE HIGH EXCEPT THE
247 REM ONE WHICH IS TO BE COMMUNICATED
250 NEXT S
260 REM
270 REM
400 S=0 :A=A+1
410 OUT 3,R(S) :GOSUB 2000 :REM TURN ON TONE
420 OUT 3,255               :REM TURN OFF TONE
425 S=S+1
430 IF S=A THEN 450 ELSE 410
450 S=0
460 W=INP(3)
465 IF W<>255 THEN 470 ELSE 460:REM HAS A BUTTON BEEN PUSHED?
470 IF W=R(S) THEN 480 ELSE 600
480 S=S+1
481 REM A IS PRESET TO EQUAL WIN NUMBER. THIS CAN BE 1 TO 64 TONES
482 IF A=16 THEN PRINT"YOU WIN":GOTO 700
490 W=INP(3)
495 IF W<>255 THEN 490 :REM HAS THE PLAYER RELEASED THE BUTTON?
500 IF S=A THEN 580
510 GOTO 460
520 REM
530 REM
580 REM RETRY DELAY
585 FOR T=0 TO 3 :GOSUB 2000 :NEXT T
590 GOTO 400
600 PRINT"SORRY,YOU MISSED IT ..... YOU HAD ";A;" NOTES IN THE
    SEQUENCE"
605 PRINT"TRY AGAIN"
610 OUT 3,0 :REM TURN ON ALL TONES
620 FOR T=0 TO 3 :GOSUB 2000 :NEXT T
625 OUT 3,255
630 GOTO 205
700 FOR T=0 TO 6 :REM PLAY TUNE TO INDICATE A WINNER
705 OUT 3,254 :GOSUB 2050 :OUT 3,253 :GOSUB 2050
710 OUT 3,251 :GOSUB 2050 :OUT 3,247 :GOSUB 2050
715 OUT 3,255: NEXT T
720 GOTO 205
1980 REM
1990 REM THE VALUE OF T1 SETS THE TONE DURATION
2000 FOR T1=0 TO 250 :NEXT T1 :RETURN
2050 REM WIN DELAY TIMER
2060 FOR Q1=0 TO 80 :NEXT Q1 :RETURN
```

Figure 1a illustrates the hardware interface of this musical game; photos 1 and 2 demonstrate typical layouts. A more detailed description of an individual tone generating section is given in figure 1b. Normally, both signal points A and B are at a high logic level and the tone is off. The tone and light can be turned on by either a low output signal from the computer or the pushbutton being pressed. The resulting high level output of IC1a turns on the oscillator formed from IC1b and IC1c and drives the light through transistor Q_1.

A flowchart of the software as written in BASIC is shown in figure 2. When the game is initialized, a random number generator sets up a tone sequence of 64 notes. After playing the first note it waits for the player's response and then repeats the action adding another note. The software is written so that the speed of player response is not important. Player frustration is strictly limited to remembering the tone sequence. The BASIC program which plays this game is shown in listing 1.

I have found that this game is a good way to demonstrate my computer to people totally unfamiliar with them. Some of my more computer oriented friends jokingly suggest that I may be doing things the hard way using a 64 K byte dual disk Z-80 system for the game.

If you have any questions, good ideas or comments on this or previous articles, please write to me, enclosing a self-addressed, stamped envelope. Eventually I answer them all.

Next month, the "Circuit Cellar" topic will be communication on a laser light beam.■



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Cross-Pollinating the Apple II

About the Author

Richard Campbell is a software engineer working for Lexitron Corporation, a manufacturer of 8080 based text processors. His hobbies include computing, flying and photography.

Richard Campbell
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Canoga Park CA 91306

I have an Apple II personal computer, which I like a great deal. I have noticed that most construction articles dealing with custom interfaces for the Apple assume that one must use Motorola or MOS Technology peripheral integrated circuits. Since I use the Intel 8080 family of devices in my work, and want to add a serial interface to my Apple, I've decided to try a little crossbreeding. The interface was designed to be RS-232 compatible and to allow receiving and transmitting with the ability to add modem control signals easily in the future.

Circuit Design

The heart of the interface is the Intel 8251 programmable communications interface. The 8251 performs serial-to-parallel and parallel-to-serial conversion. The operating characteristics and mode of the 8251 are programmable by sending the proper bytes to it from the Apple bus. The interface is set up to handle asynchronous communications. National Semiconductor's 1488 and 1489 integrated circuits handle the RS-232 and TTL (transistor-transistor logic) level conversions. Since I am using only one of four buffers per chip, many other RS-232 signals could easily be added such as *Data Set Ready* and *Clear To Send.*

Data rate generation is handled by dividing the 7 MHz signal from the Apple bus by 8, using a 74LS161 synchronous 4 bit counter. This 895.125 kHz output is applied to the input of National Semiconductor's MM5307AA programmable divider. Four switches select the data rate as shown in table 2. The resulting data rates are 3 percent low, but in actual practice this is close enough. Two gates of a 74LS04 device are required to interface the 8251 circuit to the Apple bus.

Construction

The circuit was constructed using point-to-point wiring on an Apple prototype board. This board comes with a manual which provides an excellent explanation of the Apple bus. Nothing is particularly critical about the wiring (although I wouldn't run the 7 MHz signal all around). A 0.1 μF capacitor should be placed near each integrated circuit be-

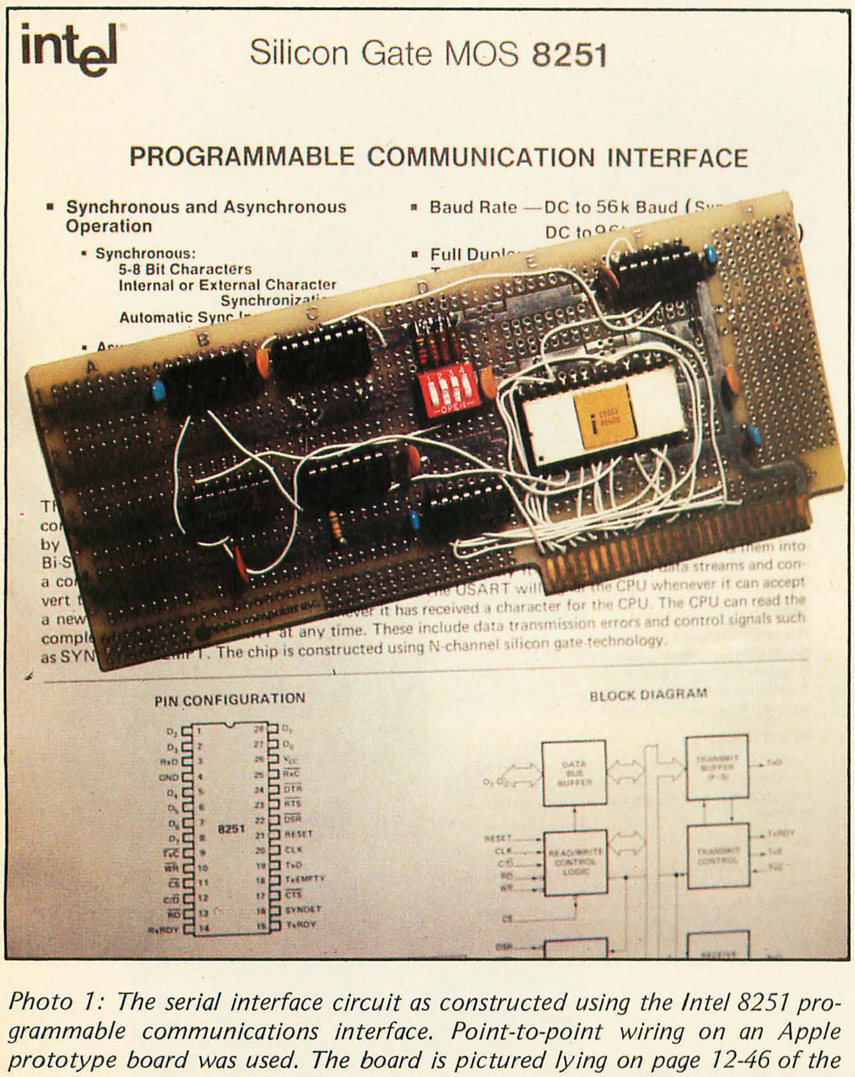
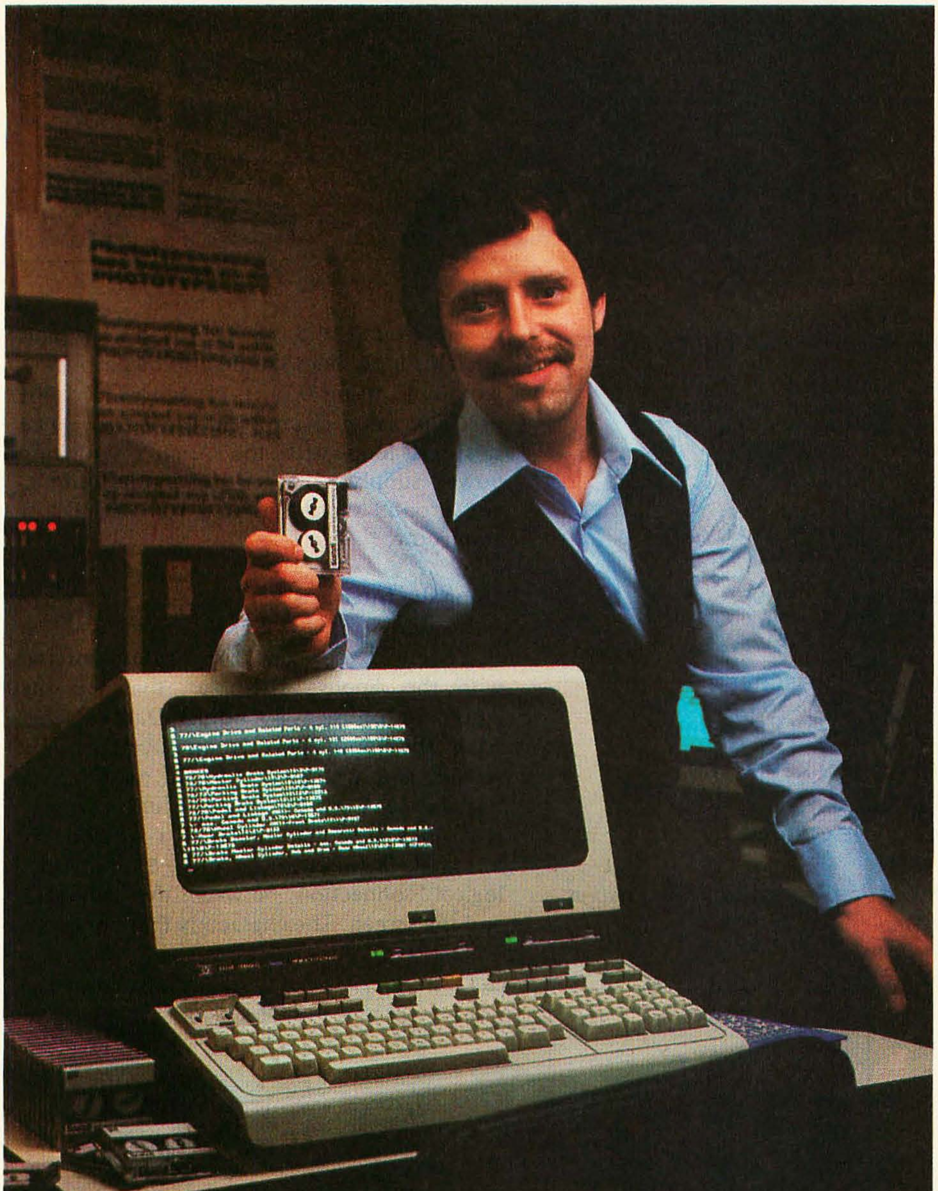


Photo 1: The serial interface circuit as constructed using the Intel 8251 programmable communications interface. Point-to-point wiring on an Apple prototype board was used. The board is pictured lying on page 12-46 of the Intel Component Data Catalog.

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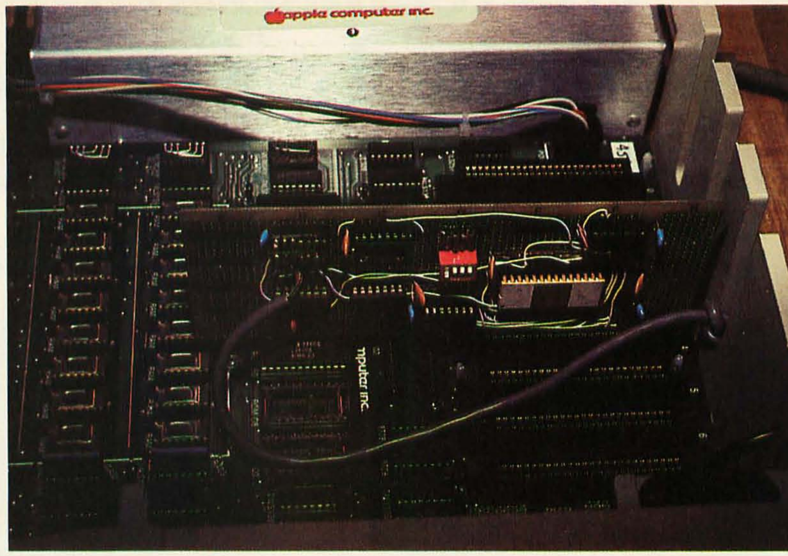


Photo 2: The serial interface board installed inside the Apple II.

```
0300 A9 CE       LDA  #$CE
0302 8D C1  C0   STA  $C0C1   SET 8251 MODE (SEE 8251 DATA SHEET)
0305 A9 27       LDA  #$27
0307 8D C1  C0   STA  $C0C1   SET 8251 COMMAND
030A 20 58  FC   JSR  $FC58   CLEAR THE SCREEN AND HOME
030D A9 60       LDA  #$60    GET CURSOR CHAR
030F 20 ED  FD   JSR  $FDED   PUT CURSOR ON SCREEN
0312 C6 24       DEC  $24     BACKUP SCREEN INDEX TO OVERWRITE
                              CURSOR
0314 AD C1  C0   LDA  $C0C1   CHECK 8251 STATUS
0317 29 02       AND  #$02    MASK OFF RECEIVE READY BIT
0319 F0 12       BEQ  $032D   BRANCH IF NOT READY
031B A9 A0       LDA  #$A0    GET A BLANK
031D 20 ED  FD   JSR  $FDED   OVERWRITE THE CURSOR
0320 C6 24       DEC  $24     BACKUP SCREEN INDEX
0322 AD C0  C0   LDA  $C0C0   GET CHAR FROM 8251
0325 09 80       ORA  #$80    SET BIT 7 HIGH
0327 20 ED  FD   JSR  $FDED   PUT CHAR ON THE SCREEN
032A 4C 0D  03   JMP  $030D   PUT UP NEXT CURSOR AND LOOP
032D 2C 00  C0   BIT  $C000   CHAR ENTERED ON KEYBOARD?
0330 10 E2       BPL  $0314   BRANCH IF NO
0332 AD 00  C0   LDA  $C000   GET CHAR FROM KEYBOARD
0335 8D C0  C0   STA  $C0C0   OUTPUT CHAR TO BE SENT BY 8251
0338 AD 10  C0   LDA  $C010   RESET KEYBOARD
033B 4C 14  03   JMP  $0314   CHECK FOR NEXT CHAR
```

Listing 1: Program in assembler language for the 6502 processor. This enables the Apple II to function as a full duplex terminal.

tween ground and +5 V. The +12 V and −12 V supply lines should also be decoupled to ground using 0.1 μF capacitors. Do not use high value electrolytic capacitors, since this interferes with the Apple's switching power supply. The RS-232 input, output, and ground should go to a standard DB25 connector.

Using the Interface

Listing 1 contains a program, entered with the Apple's assembler, that sets the Apple up for use as a terminal. Data received from the input port is displayed on the screen, and whatever is typed on the keyboard is sent out the transmit line. This program operates the Apple as a full duplex terminal. In other words, there is no internal logical connection between the keyboard and the screen. The characters that are typed



Photo 3: The serial interface is used here to connect the Apple II to an Intel SDK-80 microcomputer.

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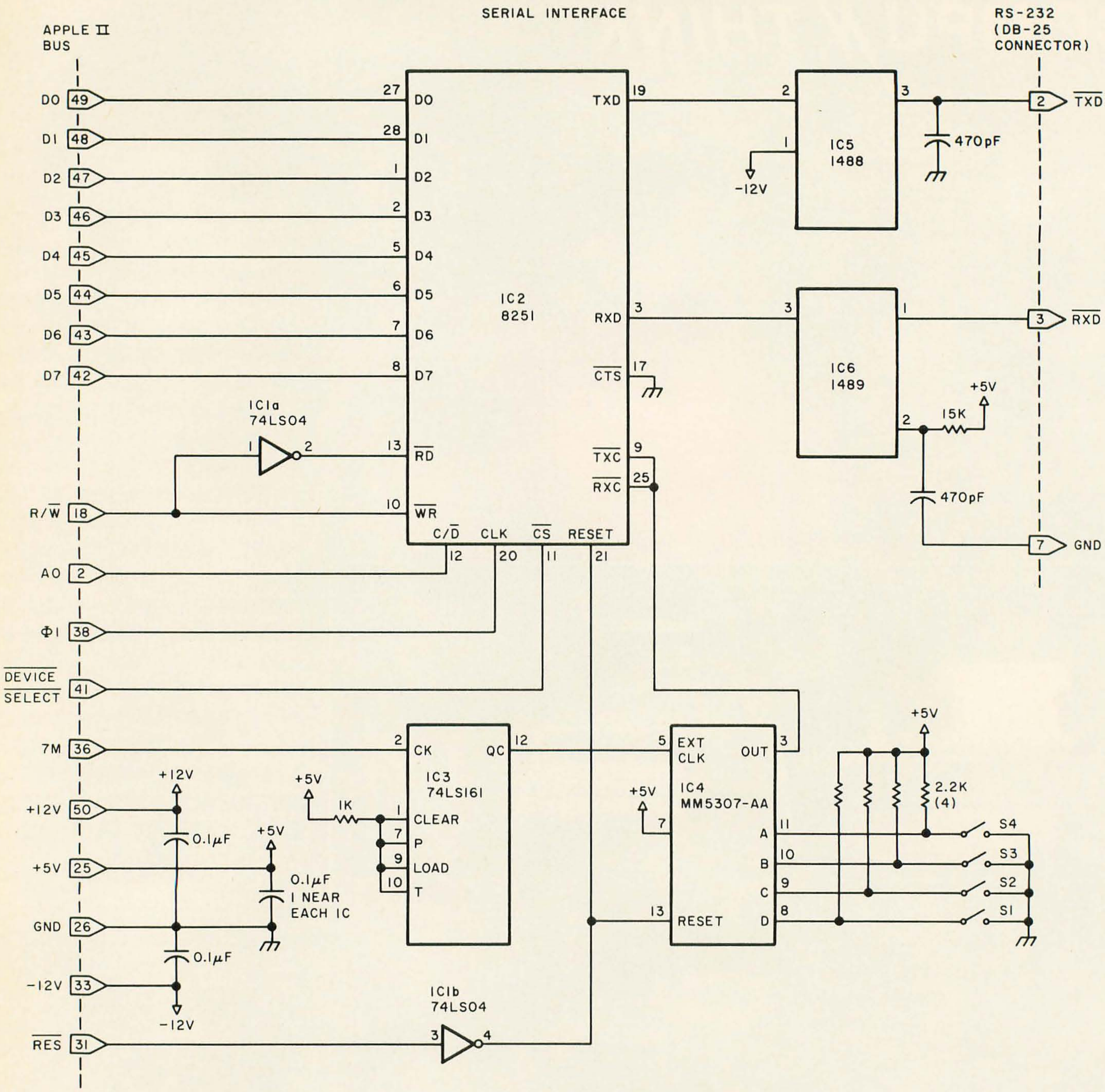


Figure 1: Schematic diagram for the serial interface.

Table 1: Power wiring table for figure 1.

Number	Type	+5 V	Gnd	−12 V	+12 V
IC1	74LS04	14	7	–	–
IC2	8251	26	4	–	–
IC3	74LS161	16	8	–	–
IC4	MM5307-AA	4	–	12	–
IC5	1488	–	7	1	14
IC6	1489	14	7	–	–

Data Rate Selection

S4	S3	S2	S1	Data Rate (bps)
C	C	C	N	50
C	C	N	C	75
C	C	N	N	110
C	N	C	C	134.5
C	N	C	N	150
C	N	N	C	300
C	N	N	N	600
N	C	C	C	900
N	C	C	N	1200
N	C	N	C	1800
N	C	N	N	2400
N	N	C	C	3600
N	N	C	N	4800
N	N	N	C	7200
N	N	N	N	9600

C = closed N = open (not closed)

8251 set for ÷16 mode

Table 2: Switch settings to select various data rates for this serial interface. A dual in line pin-type switch may be used.

appear on the screen only if the device you are communicating with echoes them back to you. With this program the board has communicated perfectly with an Intel single board computer at a data transmission rate of 600 bits per second.

Conclusion

Some experimenters have faced difficulty in attempting to interface the Apple II to such devices as the Motorola 6820 PIA (peripheral interface adapter). Most of the problems stem from a 25 ns timing delay on the bus lines of the Apple. I advise erstwhile interfacers not to become bogged down in this sort of thing; there are too many new and useful integrated circuits available with which to work.

Not all highly programmable devices are as fussy about timing as are the standard support devices for the 6800 and 6502 processors. My design shows that other families of circuits may be utilized without much trouble. The design using the 8251 device has suffered no timing glitches such as the ones that plague circuits using the 6820 device.

The moral is to keep your eyes open to discover new and versatile integrated circuits and to experiment with them, whatever processor you use. Signetics has invented an interface circuit, the 2651, which is similar to the 8251. The principal difference is a built-in data rate generator. If I can obtain one, I know what my next experiment will be.■

Simulating Physical Systems

The Two-Dimensional Ideal Gas

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Caltech 130-33
Pasadena CA 91125

Computers are becoming increasingly valuable in the sciences, for data reduction and analysis and for the simulation of physical systems. With a machine to do the repetitious work, an astronomer can follow the orbits of hundreds or thousands of stars as they are affected by their mutual gravitational fields and move to make a globular cluster or a spiral galaxy. A chemist can follow molecules in a liquid as they attract and repel and undergo chemical reactions. A physicist can watch the atoms of a gas moving from a low entropy, highly ordered state toward a more probable chaotic configuration, and can follow the random walk motion of any specific particle as it suffers collisions with the rest of the gas.

How does one go about setting up a physical simulation? It's necessary to determine the most important laws that govern the system under investigation. A star cluster, for example, is controlled mainly by Newton's law of gravitation. The nuclear reactions which power individual stars are interesting, but probably not very important to the structure of the cluster as a whole. (An exception might be a cluster of extremely massive stars; such stars could run out of fuel and blow up before there was time for their orbits to settle down.)

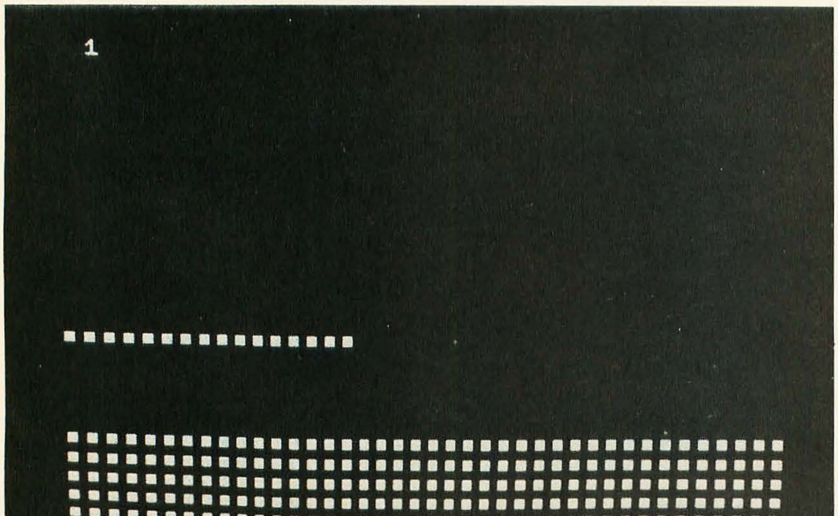


Photo 1: Initial configuration for a run of the ideal gas model.

The first step in programming any physical system is to cut away all the features except those which are crucial to it – in other words, to make a model. If the correct effects and features have been included, the model will act enough like the physical system to be useful and accurate, and the model will be small and simple enough to be computable in a reasonable amount of time and space.

Secondly, one must take the equations that govern the model and translate (and sometimes simplify) them into a form which a machine can handle. Today, only a few very high-level systems (such as MACSYMA, REDUCE, SHEEP, and FORMAC) can handle abstract equations and functions, and even these sophisticated systems can't do very much. Until people learn how to explain the details of problem solving mathematics better, most machines are best at manipulation of discrete, finite precision numbers. So, if one wants to compute the flight of a Frisbee, one needs to turn the continuous differential equations for its motions into discrete difference equations. It's analogous to the way one plots a diagonal line on a teletypewriter – the continuous line is broken up into a discrete set of points that the printer then approximates as best it can. If the printer can type smaller, the approximation is better. Similarly, if the smooth equations describing the Frisbee's flight are broken up into tinier steps, then the approximate solution the machine generates comes closer to the actual motion.

Finally, given the model of the physical system to be simulated, and given a translation of the equations controlling that model into a machine acceptable form, the rest is easy: just write the program! Ah, if it were only so. To avoid gross errors and smaller bugs, it's best to write in a high-level language (BASIC, FORTRAN, Pascal, etc), but then the resulting code usually runs unacceptably slowly. It seems to be a general consequence of Murphy's Law ("Anything that can go wrong, will!") that any physical system interesting enough to be worth simulating is too complex to be effectively simulated. So, compromises are always necessary. Astronomers try to simulate galaxies using a thousand point masses and an approximate force law, instead of using the actual ten billion stars with $1/r^2$ fields. Chemists settle for a few hundred molecules in their "liquid," instead of 10^{23} or so. All they can do is hope that enough of the many-body collective effects show up for their too small models to be interesting, and that the cost of computing comes down enough for them to simulate bigger systems next year. As calculations get cheaper, that last hope seems to be the best.

Another way to compromise between the human speed and efficiency of programming in a high-level language, and the computer speed and efficiency of programming in machine language is obvious: do both, and produce a hybrid program. The BASIC (or Pascal, or whatever) program provides the framework and handles non-time-critical tasks; it then calls machine language modules to perform the innermost loops, the time-consuming parts of the program which are simple enough to write accurately and rapidly in such a low-level language. As a developmental tool, this top-down approach is infinitely better than writing all machine language code and then spending days debugging it. In fact, if the program can be entirely written in the high-level language

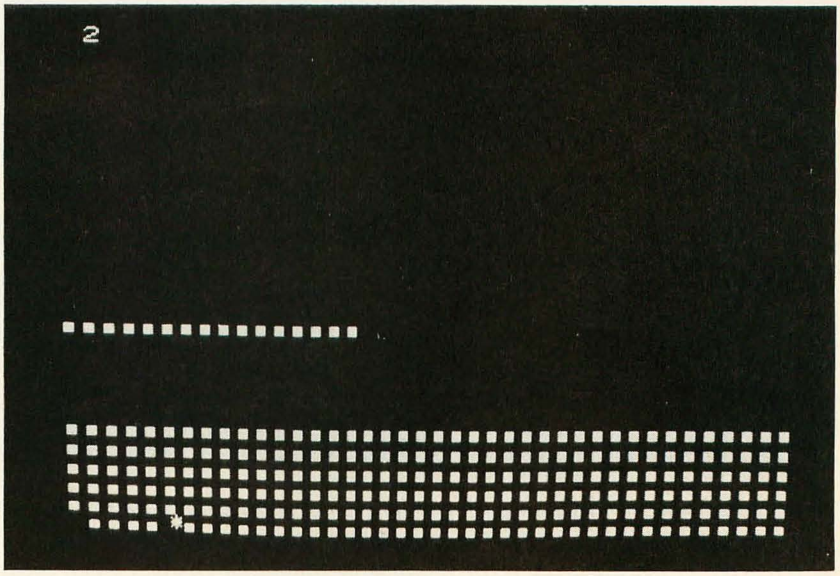


Photo 2: One time step later, particle number 0 has moved ten units to the right and is colliding with particle number 31 at X=10, Y=0.

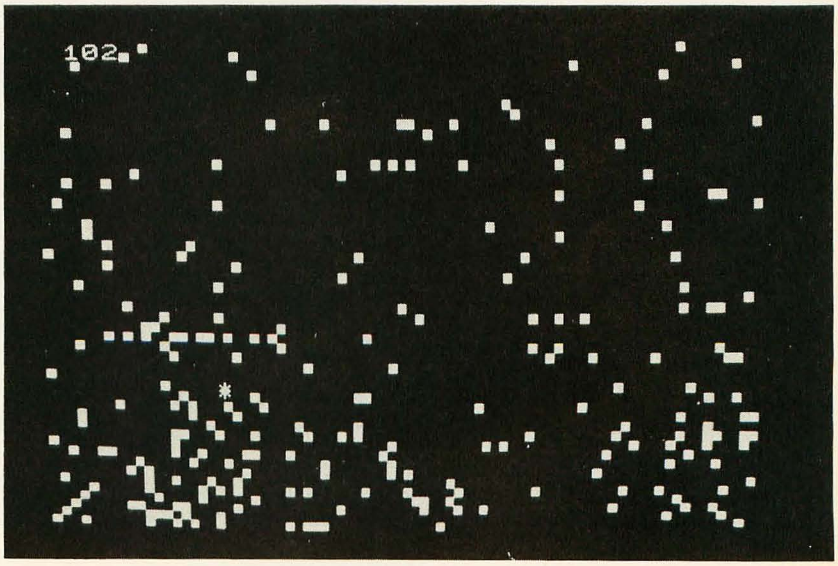


Photo 3: A view of the simulation 102 time steps after starting.

and then run (slowly, perhaps) on small, special cases to test out the fundamental equations, so much the better. The machine language subroutines can then be written and substituted in only as necessary.

With this 3 step approach (model, translate, program), simulating physical systems isn't necessarily easy, but it is systematic and can be interesting and educational.

The Ideal Gas

As an application of the above principles, I've programmed in BASIC and 6502 machine language (on a Commodore PET) a simulation of an ideal gas – a gas made of pointlike particles that interact only by direct collisions. An actual gas, of course, is made of molecules or atoms which have size and internal structure. The molecules may react when they collide with sufficient energy, and they may influence each other (via electrical forces) even when they are quite far apart. The gas may condense into a liquid or solid phase if its temperature is low enough and its pressure high enough.

The model I made does not include those features. It doesn't even include the three dimensions in which the physical gas moves! For speed and simplicity, I restricted the gas particles to move in two dimensions within the 50 by 80 cell "box" of the PET's video screen. The two-dimensional gas is interesting in itself, and it actually occurs, approximately, when atoms get adsorbed on the surface of some crystals. The adsorbed particles are relatively free to move from place to place on the crystal surface, but they are not free to leave the surface if the temperature is low enough. (If this physical system isn't exciting enough for you, you can imagine that the program is simulating a large number of balls on a billiard table, or perhaps hockey pucks sliding on ice.)

Several other features of the model I made are important. I used only 256 gas particles for two reasons: it made the machine language routines simpler, and more particles would have filled up too large a fraction of the screen. As a general rule, the errors in simulating a random process shrink as $1/\sqrt{N}$, where N is the number of objects in the simulation. For example, if a pollster asks 100 randomly chosen people for their opinion on some issue, he or she typically makes about $1/\sqrt{100} = 10\%$ errors in estimating the general opinion based on the finite sample. If the average number of molecules in one cubic centimeter of air is

Text continued on page 32.

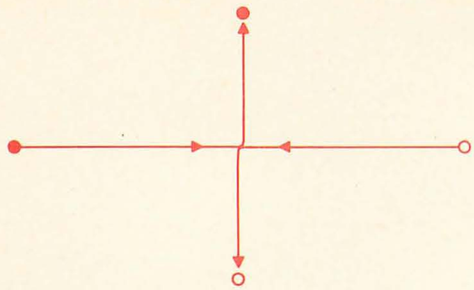


Figure 1: 90 degree type collision for two particles with equal and opposite initial velocities.

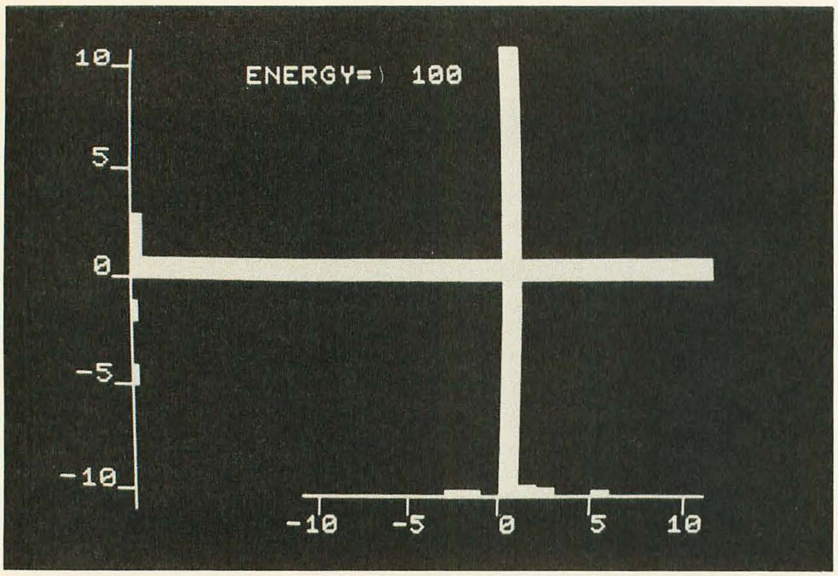


Photo 4: A velocity distribution histogram after 102 steps. Note the energy error (possibly due to roundoff and truncation error, or maybe I accidentally hit the G key). Energy error is worse at these low energies when most particles have only very small velocities.

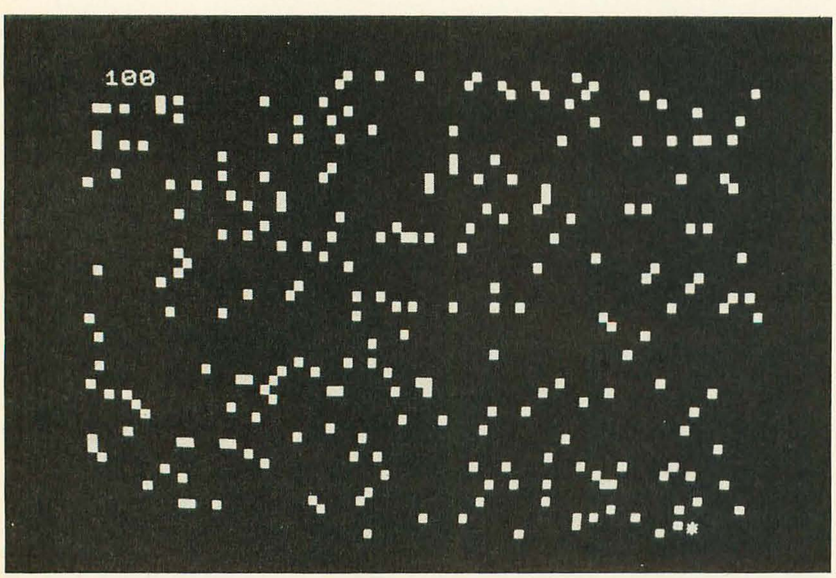


Photo 5: Configuration for a high temperature gas with a total energy of 1207 units.

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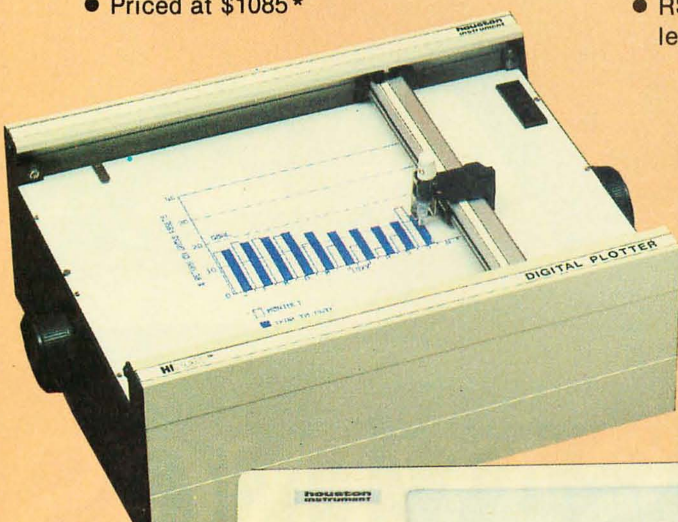
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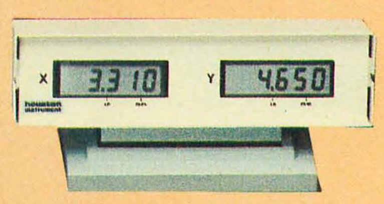
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7424 thru 7679	Low bytes of VX velocities.
7680 thru 7935	High bytes of VY velocities.
7936 thru 8191	Low bytes of VY velocities.
10	Current screen character at location to be plotted.
11 thru 25	Table of PET ¼ graphics symbols; translates to and from "binary graphics symbols."
26,27	Low, high bytes of current screen address.
28	"Binary graphics symbol" to be put onto current location (1, 2, 4, or 8).
29,30	High, low bytes of M=(A+B+C+D)/2.
31,32	High, low bytes of TEMP=M−B.
6050 thru 6074	Low bytes of table of left ends of screen lines.
6075 thru 6099	High bytes of table of left ends of screen lines.
6100 thru 6114	Table of graphics symbols, in order defined to be 1, 2, 3, 4, . . . , 15 in "binary graphics symbols."
5632 thru 5654	Move X coordinate.
5655 thru 5660	Check to see if in box; fix if not.
5661 thru 5679	Move Y coordinate.
5680 thru 5685	Check to see if in box; fix if not.
5686 thru 5689	Increment counter; do next particle if not done.
5690 thru 5726	Fix if gone off left edge.
5727 thru 5746	Fix if gone off right edge.
5747 thru 5779	Fix if gone off bottom.
5780 thru 5799	Fix if gone off top.
5800 thru 5809	Transfer table to page 0 of memory.
5810 thru 5824	Put address of screen left edge of line to be plotted into 26,27.
5825 thru 5848	Put "binary graphics symbol" to be plotted into 28, and add location in line to be plotted to 26,27.
5849 thru 5866	Find current graphics symbol which occupies space to be plotted in; look up in table and translate to "binary graphics symbol."
5867 thru 5882	Plot particle if space to which it goes isn't already occupied.
5883 thru 5886	Increment counter and go back to 5810 if not through.
5887 thru 6036	A collision has occurred! Scan back to see which particle has collided with the one about to be plotted, and fix their velocities, as in text.
6037 thru 6049	This space intentionally left blank.

Table 1: Comments on Gas machine language modules given in listing 2.

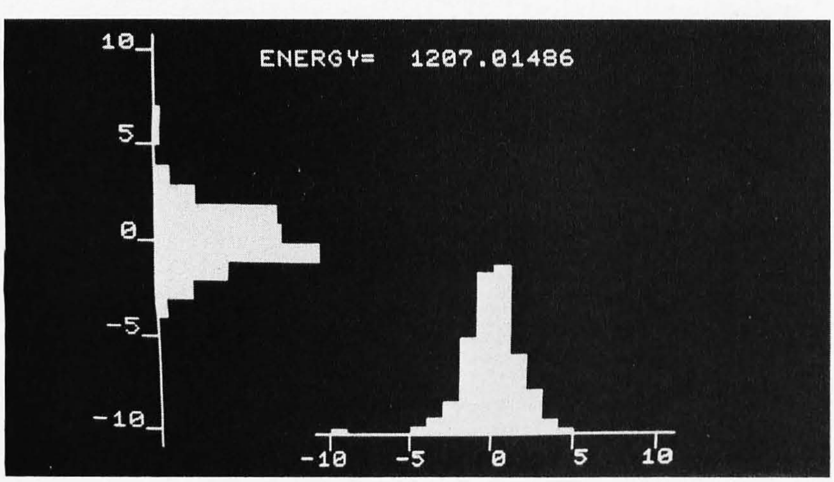


Photo 6: Velocity histogram for the high temperature gas shown in photo 5.

Text continued from page 28:

3×10^{19}, then the fractional fluctuation in this number is about $1/\sqrt{3 \times 10^{19}} \approx 0.2$ parts per billion — small, but measurable. (The human ear is sensitive enough to barely hear these fluctuations — try it, if you can find a quiet enough place!) So, the errors that the 256 particle gas model will tend to make are of the order of $1/\sqrt{256} \approx 6\%$ — not terribly bad.

A second important feature of my model is the way it handles collisions. Time is broken into steps, and two particles which end a timestep in the same cell are considered to collide. It would be far more complicated to calculate distances between particles as they move and to declare a collision only if their center-to-center distance fell below a certain limit. It also turns out not to matter much, as far as the final equilibrium state of the gas is concerned. Actual collisions are sometimes grazing, sometimes head-on, and generally everywhere in between, depending on the details of the interactions between the molecules and their impact parameters. None of that really matters for our purposes.

The important feature of all collisions in gasses is that the collisions always conserve energy and momentum. Energy is just kinetic energy for pointlike particles: $\frac{1}{2}mv^2$. To simplify the arithmetic, I let all of my gas particles have mass m = 2, so their energies are just the squares of their velocities. In two dimensions, velocity has components along the X and Y axes; call them VX and VY. The momentum of a particle is just its mass times its velocity. Momentum thus has X and Y components, each of which must separately be conserved, that is, remain constant during a collision.

To be specific, suppose that VX and VY are arrays, and that particles numbered 1 and 2 are colliding. If arrays WX and WY are used to hold their velocities after the collision, then conservation of energy says that (total energy after)=(total energy before), that is, $WX(1)^2+WY(1)^2+WX(2)^2+WY(2)^2= VX(1)^2+VY(1)^2+VX(2)^2+VY(2)^2$. Conservation of X momentum says that WX(1)+ WX(2)=VX(1)+VX(2), and conserving Y momentum implies that WY(1)+WY(2)= VY(1)+VY(2).

Now, if the velocities before the collision are known, then there are four velocities afterwards to solve for: WX(1), WY(1), WX(2), and WY(2). Three equations are not enough information to solve for four unknowns. The missing equation contains the details of the collision — whether it is head-on or glancing or what. One might write out this fourth equation (it's done in most freshman physics textbooks) in terms

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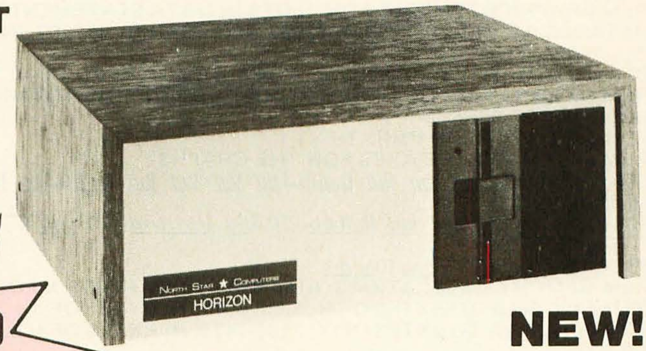
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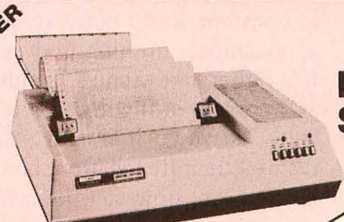
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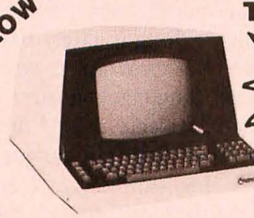


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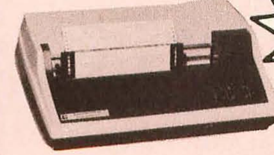
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Listing 1: BASIC program for the PET which simulates an ideal gas. This program uses the assembly language modules shown in listing 2. The notation used in this listing is described in table 3.

```
1    REM POKE 135,22 FOR SAFETY!! (KEEP BASIC BOUNDED)
10   REM GAS COPYRIGHT 1978 MARK ZIMMERMANN
15   REM GRAPHICS SYMBOLS FOR PLOTS IN DATA STATEMENTS
20   DATA 100, 111, 121, 98, 248, 247, 227, 160, 101, 116, 117, 97, 246, 234,
     231, 160
30   DIM UP(7), RI(7), VY(20),VX(20): FOR I=0 TO 7: READ UP(I): NEXT I
35   REM UP ARRAY IS FOR UPWARD GRAPH, RI FOR RIGHTWARD; VY & VX
     HOLD VELOCITIES
40   FOR I=0 TO 7: READ RI(I): NEXT I
45   REM SC$ DRAWS THE AXES FOR THE GRAPHS
50   SC$="cls 10┘bd |bd |bd |bd |bdb5┘bd |bd |bd |bd |bdb0┘bd |bd |bd
     |bd |bdbb–5┘"
60   SC$=SC$+"bd |bd |bd |bd |bdbbb–10┘bd |rrrrrrrd–10 ubb┬─┐bd–5bu
     ──┬bd0u──┐"
70   SC$=SC$+" bd5u──┬bbd10home"
80   REM MEMORY ALLOCATIONS: 6144-6399, HI BYTES OF X COORDINATES
82   REM 6400-6655, LO BYTES OF X; 6656-6911, HI BYTES OF Y
84   REM 6912-7167, LO BYTES OF Y; 7168-7423, HI BYTES OF VX; 7424-7679,
     LO VX
86   REM 7680-7935, HI BYTES OF VY; 7936-8191, LO BYTES OF VY
90   PRINT "HIT 'R' TO RESET TIMER"
95   PRINT "     'S' TO MOVE SLOWER"
100  PRINT "     'F' FOR FASTER"
105  PRINT "     'G' TO GOOSE PARTICLE #0"
110  PRINT "AND ANY OTHER KEY TO PLOT VELOCITIES"
115  REM 120-140 FILL THE VELOCITIES WITH ZEROES AND THE LO BYTES
     OF POSITIONS
117  REM TO CENTER THE PARTICLES IN THEIR RESPECTIVE SQUARES
120  FOR I=0 TO 255
130  POKE 7168+I,0: POKE 7424+I,0: POKE 7680+I,0: POKE 7936+I,0
140  POKE 6400+I,128: POKE 6912+I,128: NEXT I
150  REM ARRANGE PARTICLES NICELY HERE
160  FOR I=0 TO 39: FOR J=0 TO 5
180  POKE 6144+I*6+J,2*I: POKE 6656+I*6+J,2*J:NEXT J: NEXT I
190  REM USE UP ALL PARTICLES!
200  FOR I=240 TO 255: POKE 6144+I,2*(I–240): POKE 6656+I,20: NEXT I
300  DE=30: REM PRELIMINARY TIME DELAY
350  :
400  SYS(5632): REM MOVE ONE TIMESTEP
420  :
450  PRINT "cls";:N=N+1:REM CLEAR SCREEN; N COUNTS TIME
480  :
500  SYS(5800):REM PLOT & COLLIDE THEM!
520  :
540  PRINT N:T=TI
550  X0=INT(PEEK(6144)/2):Y0=INT(PEEK(6656)/2): POKE 33728+X0–40*Y0,
     42:REM MARK #0
560  IF (TI–T) < DE GOTO 560: REM DELAY
600  GET A$: IF A$="" GOTO 400
610  IF A$="R" THEN A$="":N=0:GOTO 400
620  IF A$="S" THEN A$="":DE=2*DE: GOTO 400
630  IF A$="G" THEN A$="": POKE 7168,10: GOTO 400
640  IF A$="F" THEN A$="":DE=DE/2: GOTO 400
650  A$="":E=0:PRINT SC$
670  FOR I=0 TO 20: VX(I)=0: VY(I)=0: NEXT I: REM CLEAR
     ACCUMULATORS
700  FOR I=0 TO 255: HX=PEEK(7168+I): HY=PEEK(7680+I): LX=PEEK(7424+I)
720  LY=PEEK(7936+I): REM CALCULATE VELOCITIES, ADJUST IF NEGATIVE
740  IF HX > 127 THEN HX=HX–255: LX=LX–256
760  IF HY > 127 THEN HY=HY–255: LY=LY–256
780  VX=HX+LX/256: VY=HY+LY/256: E=VX*VX+VY*VY+E: REM ADD UP
     ENERGY
785  : : : : : : :REM NOW COMES PLOTTING: : : : : : :
790  VX=INT(VX): VY=INT(VY): IF(VX > 10)OR(VX < –10) THEN VX=
     SGN(VX)*10
795  REM LIMITS PLOTS TO BETWEEN –10 & 10
800  IF (VY > 10) OR (VY < –10) THEN VY=SGN(VY)*10
810  VX=VX+10:VY=VY+10
815  REM ACCUMULATE COUNTS IN VX & VY ARRAYS; SCALARS VX & VY
     ARE DIFFERENT!!
820  VX(VX)=VX(VX)+1: VY(VY)=VY(VY)+1: AX=33582+VX–40*INT(VX(VX)/8)
825  REM CALCULATE AX AND AY, ADDRESSES FOR PLOT OF A GIVEN VX
     AND VX(VX), ETC.
830  AY=33572–40*VY+INT(VY(VY)/8)
840  CX=UP(VX(VX)–8*INT(VX(VX)/8)): CY=RI(VY(VY)–8*INT(VY(VY)/8))
845  REM CX & CY ARE GRAPHICS CHARACTERS USED FOR SOME VX OR VY
850  POKE AX,CX: POKE AY,CY
860  NEXT I
1000 PRINT TAB(10);"ENERGY=";E
1020 GET A$: IF A$="" GOTO 1020: REM WAIT UNTIL DONE LOOKING AT
     GRAPHS
1100 GOTO 400
```

of the scattering angle, and then use the details of the particles' positions to choose that angle, but that would involve calculating sines and cosines of the angle, and it's unnecessarily slow and complicated (especially to program in machine language). Instead, I chose one special type of collision, which enabled WX(1), WX(2), WY(1), and WY(2) to be calculated using only addition, subtraction, and division by 2. (I can program those!) This special collision scatters two particles by 90 degrees, if they approach each other with opposite velocities, as shown in figure 1. The resulting equations for the velocities after the collision are simple. Let M=(VX(1)+VY(1)+VX(2)+VY(2))/2. Then WX(1)=M–VY(1), WY(1)=M–VX(2), WX(2)=M–VY(2), and WY(2)=M–VX(1). It's an exercise in elementary algebra to see that these values for the velocities after the collision conserve energy and momentum.

So that's the specific model: a two-dimensional gas made of 256 particles on a 50 by 80 grid, which make 90 degree type collisions whenever two fall in the same cell. Now for step 2: make the equations of motion computable. The equation that governs the particles' positions between collisions is, in words, that the time-rate-of-change of the position is the velocity; the velocity is constant. It's the simplest differential equation imaginable, and the solution is also simple: particles move in straight lines at constant speed between collisions. But in a machine, nothing moves continuously. It's rather like Zeno's Paradox: if you look at an arrow in flight, at some moment it certainly is where it is, not somewhere else — it's at a definite location, not smeared out or blurred. So, how can the arrow move? Zeno couldn't answer this (or chose not to), but later mathematicians (Newton, Leibnitz, and others) did. Their answer involves looking at the motion as a series of tiny discrete jumps. The computer can do that too. If a particle is at position X,Y at one moment, and has velocity VX, VY, then a time T later it will be at X+T×VX, Y+T×VY. When I wrote the original (high-level language) version of this simulation, I used precisely these "timestep" formulae; in the machine language version, I set T = 1 for simplicity. I also chose a specific precision arithmetic: two bytes for each number, in 2's complement notation, with the decimal point (it's really a binary point!) between the two bytes. The high byte (to the left of the point) gives a number that can be directly plotted on the screen; the low byte keeps several decimal places of accuracy and holds down roundoff

Text continued on page 38.

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Listing 2: The 6502 assembly language modules for use with the ideal gas program.

```
LABEL        MNEMONIC         COMMENTS

BEGINMOVE:   LDX  #0          ;initialize particle counter
             LDY  #0          ;clear Y register
      TOP:   LDA  VXLO,X      ;move x coordinate of particle
             CLC              ;by adding VX to X
             ADC  XLO,X
             STA  XLO,X
             LDA  VXHI,X
             ADC  XHI,X
             STA  XHI,X
             BMI  NEGX        ;bounce off left wall if x.LT.0
             CMP  #80
             BCS  BIGX        ;bounce off right wall if x.GE.80
     RETX:   LDA  VYLO,X      ;move y coordinate
             CLC              ;by adding VY to Y
             ADC  VLO,X
             STA  YLO,X
             LDA  VYHI,X
             ADC  YHI,X
             STA  YHI,X
             BMI  NEGY        ;bounce off bottom if y.LT.0
             CMP  #50
             BCS  BIGY        ;bounce off top if y.GE.50
     RETY:   INX
             BNE  TOP         ;do all 256 particles
             RTS              ;back to BASIC control
     NEGX:   TYA              ;prepare to reflect -x to x
             SEC              ;by subtracting from 0
             SBC  XLO,X
             STA  XLO,X
             TYA              ;another 0 in accumulator
             SBC  XHI,X
             STA  XHI,X
   REFLVX:   TYA              ;reflect velocity vx also
             SEC
             SBC  VXLO,X
             STA  VXLO,X
             TYA
             SBC  VXHI,X
             STA  VXHI,X
             JMP  RETX        ;return to main program
     BIGX:   LDA  #255        ;prepare to reflect x to 160-x
             SEC              ;(actually, 159.99. . .-x)
             SBC  XLO,X
             STA  XLO,X
             LDA  #159
             SBC  XHI,X
             STA  XHI,X
             JMP  REFLVX      ;reflect velocity vx using previous code
     NEGY:   TYA              ;reflect y to -y
             SEC
             SBC  YLO,X
             STA  YLO,X
             TYA
             SBC  YHI,X
             STA  YHI,X
   REFLVY:   TYA              ;reflect velocity vy also
             SEC
             SBC  VYLO,X
             STA  VYLO,X
             TYA
             SBC  VYHI,X
             STA  VYHI,X
             JMP  RETY        ;return to main program
     BIGY:   LDA  #255        ;prepare to reflect y to 99.99 . . .-y
             SEC
             SBC  YLO,X
             STA  YLO,X
             LDA  #99
             SBC  YHI,X
             STA  YHI,X
             JMP  REFLVY      ;use previous code to reflect vy
```

Listing 2 continued on next page.

BEGINMOVE	5632
BEGINPLOT	5800
XHI	6144
XLO	6400
YHI	6656
YLO	6912
VXHI	7168
VXLO	7424
VYHI	7680
VYLO	7936
OLDCHAR	10
GRAFTAB	11
ADDRNOW	26
NEWSYMB	28
MHI	29
MLO	30
TMPHI	31
TMPLO	32
SCRTABLO	6050
SCRTABHI	6075
SYMBTAB	6100

Table 2: Specific addresses used in the 8 K byte PET Gas program. Addresses are given in decimal.

cls	=	clear screen.
b	=	backspace (cursor left).
d	=	down (cursor down).
r	=	right (cursor right).
u	=	up (cursor up).
home	=	cursor home.

Table 3: The PET uses special graphics symbols to denote cursor control characters. Since these special characters cannot be typeset, the above notation is used in the program.

Text continued from page 34:

or truncation errors. When an X coordinate ends up less than 0 or greater than 80, I reflect the particle off the left or right wall and reverse its X velocity; when a Y coordinate falls outside the box's range (0 to 50), I do the same for it. (Since I don't check for arithmetic overflows, if velocities get larger than about 32, there is a chance for error; this isn't a serious restriction, in practice.) In this format, addition and subtraction are trivial, and the only trick to dividing by 2 is to get the sign bit correct after shifting right.

That's all there is to the model. The details that are explained in the remarks in the BASIC listing (listing 1), and in the commentary about the listing 2 machine language modules in table 1, are probably of interest mainly to 6502 system users, especially PET owners who can use the program without modification. (At top speed, it makes about seven timesteps per second!) Much more interesting in general are the "bells and whistles" that can be added to the bare model for convenience and physical insight.

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Listing 2, continued:

```
BEGINPLOT:  LDX  #15          ;transfer graphics symbol table to page 0
   LOOP01:  LDA  SYMBTAB–1,X          ;binary symbols allow quarter-character
            STA  GRAFTAB–1,X          ;high resolution graphics
            DEX
            BNE  LOOP01
  TOPPLOT:  LDA  YHI,X        ;get a particle's y coordinate
            LSR  A            ;divide by 2
            TAY
            LDA  SCRTABLO,Y           ;look up screen address in table
            STA  ADDRNOW              ;for left end of screen line to be
            LDA  SCRTABHI,Y           ;plotted on
            STA  ADDRNOW+1            ;and store on page 0
            LDA  #1
            BCC  SKIP01       ;if carry is clear then y coordinate was even
            LDA  #4           ;before division by 2
   SKIP01:  STA  NEWSYMB              ;store #1 or #4 here, if y even or odd
            LDA  XHI,X        ;get particle's x coordinate
            LSR  A            ;divide by 2
            BCC  SKIP02       ;skip if x was even
            ASL  NEWSYMB              ;double NEWSYMB if x odd
   SKIP02:  ADC  ADDRNOW              ;add x/2 to left edge address
            STA  ADDRNOW              ;to get plotting address
            BCC  SKIP03       ;skip if no carry
            INC  ADDRNOW+1
   SKIP03:  LDY  #0
            LDA  (ADDRNOW),Y          ;get symbol currently occupying
                                      particle's
            STA  OLDCHAR              ;target plotting cell, OLDCHAR=
                                      GRAFTAB–1
            LDY  #15          ;prepare to look up symbol in table
   LOOP02:  CMP  OLDCHAR,Y
            BEQ  FOUND IT             ;exit when found in table
            DEY
            JMP  LOOP02       ;have no fear, it will always be found! – OLD-
                              CHAR=GRAFTAB–1
  FOUNDIT:  TYA               ;binary symbol in Y register, one bit for each ¼
                              cell
            AND  NEWSYMB              ;check for a collision
            BNE  HIT          ;a hit!!! no need to plot, but must collide veloc-
                              ities now
            TYA               ;restore old binary symbol to accumulator
            ORA  NEWSYMB              ;add new bit
            TAY
            LDA  OLDCHAR,Y            ;look up new plotting symbol
            LDY  #0
            STA  (ADDRNOW),Y          ;plot new symbol
    INCRX:  INX               ;increment particle counter
            BNE  TOPPLOT              ;loop until done
            RTS               ;back to BASIC control
      HIT:  TXA
            TAY               ;transfer particle counter to Y register
   LOOP03:  LDA  XHI,X        ;colliding particle's x coordinate in accumulator
     SEEK:  DEY
            CMP  XHI,Y        ;look for the (previously plotted) colliding particle
            BNE  SEEK         ;loop until found a matching x coordinate
            LDA  YHI,X        ;do their y coordinates match too??
            CMP  YHI,Y
            BNE  LOOP03       ;if not, keep looking
            LDA  VXLO,X       ;match found – prepare to collide velocities
            CLC
            ADC  VXLO,Y
            STA  MLO          ;MLO and MHI store M=(VX1+VY1+VX2+
                              VY2)/2
            LDA  VXHI,X
            ADC  VXHI,Y
            STA  MHI
            LDA  MLO
            CLC
            ADC  VYLO,X
            STA  MLO
            LDA  MHI
            ADC  VYHI,X
            STA  MHI
            LDA  MLO
            CLC
            ADC  VYLO,Y
            STA  MLO
            LDA  MHI
            ADC  VYHI,Y       ;now we've got the sum, must divide by 2
                              to get M
            CMP  #128         ;first, essential to set carry flag for proper
                              division
```

Listing 2 continued on next page.

First, it's easy to write a loop to add up the kinetic energy of each particle; the total energy of the system should be conserved. Roundoff (from the division by 2, in particular) does make small errors occur, but I've found them to be tiny even after hundreds of timesteps. It is interesting to note that the energy is directly proportional to the temperature of the system. The eye can easily tell the difference between "hot" and "cold" gasses, with some experience.

It is also interesting to plot the velocities of the gas particles. In theory, after lots of collisions have occurred, the distributions of VX and VY velocities should be bell shaped (also called "Gaussian" or "normal") curves (see photos). It's quite satisfying to see a ridiculous initial distribution, with all the particles at rest except for one, evolve as collisions happen toward the normal curve. (The width of the distribution is proportional to the square root of the temperature.) There are fluctuations away from this equilibrium distribution, of course, but they are small, roughly $1/\sqrt{N} \approx 6\%$ in this model.

Another educational phenomenon that this model can illustrate is called Brownian motion, the "random walk" that a particle in the gas executes as it is buffeted by other objects. It's a 1 line addition to the original program to change the symbol for one particle (number 0, for example) to something distinctive, so its motion can be followed. (An asterisk was used in the photos here.) On long timescales, the net motion of a particular particle is less than one might expect – the average distance it moves is *not* (average speed)$\times$(time), but (average speed)$\times\sqrt{(\text{time})}$. (Albert Einstein got his Nobel Prize partly for his explanation of Brownian motion, published in 1905.)

There are many other "theoretical experiments" that one can do with this model of a gas. One could count the collisions off a wall and check the *ideal gas law* which relates pressure, density, and temperature. Another experiment could be to measure the "speed of sound" in the gas, by giving a push to the particles on one side of the box, and seeing how long it takes the resulting density wave to move across. (The box may be too small and the gas too dilute to do this cleanly, however; I'm not sure.) It might be nice to connect up the screen edges, so that particles which move off the right side appear at the left, etc. That way, one could set up a "wind" (a net nonzero momentum in some direction) and it would last forever (within roundoff) without hitting any box walls. Another possibility is to evolve a system forward in time for a while, and then reverse all velocities.

Effectively, this reverses time—if roundoff is unimportant, the particles should retrace their paths and return to the initial configuration, like a movie run backwards!

This simulation of a gas is extraordinarily simple in principle, but displays a surprising wealth of realistic physical phenomena. It's not surprising that slightly more complicated laws, acting on larger numbers of particles, can make galaxies and DNA molecules, snowflakes and cyclones. The challenge is to simplify and then simulate them!■

BIBLIOGRAPHY

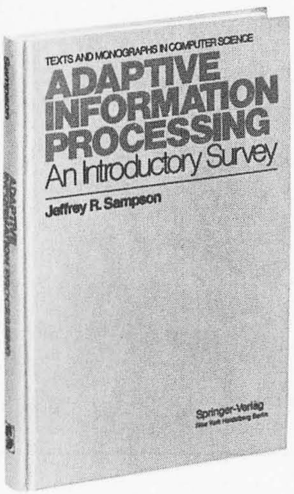
1. Aarseth, Sverre J, and Myron Lecar, "Computer Simulations of Stellar Systems," *Annual Reviews of Astronomy and Astrophysics*, volume 13, 1975, pages 1 thru 22.
2. Lykos, Peter (editor), "Minicomputers and Large Scale Computations," from a symposium sponsored by the ACS Division of Computers in Chemistry, American Chemical Society, Washington DC, 1977. (See chapters 11 and 12 in particular.)
3. Reif, F, *Statistical Physics (Berkeley Physics Course)*, volume 5, McGraw-Hill, New York, 1967.

Listing 2, continued:

```
ROR  A          ;otherwise sign bit will be lost!!!
STA  MHI
ROR  MLO        ;division by 2 completed
LDA  MLO        ;calculate after-collision velocities now,
                as described
SEC             ;in text
SBC  VYLO,X
STA  TMPLO      ;save in temporary place
LDA  MHI
SBC  VYHI,X
STA  TMPHI
LDA  MLO        ;proceed to collide all velocities
SEC
SBC  VXLO,Y
STA  VYLO,X
LDA  MHI
SBC  VXHI,Y
STA  VYHI,X
LDA  MLO
SEC
SBC  VYLO,Y
STA  VXLO,Y
LDA  MHI
SBC  VYHI,Y
STA  VXHI,Y
LDA  MLO
SEC
SBC  VXLO,X
STA  VYLO,Y
LDA  MHI
SBC  VXHI,X
STA  VYHI,Y
LDA  TMPLO
STA  VXLO,X
LDA  TMPHI
STA  VXHI,X
JMP  INCRX      ;collision finished — go back to main program
```

Book Reviews

Adaptive Information Processing: An Introductory Survey
by Jeffrey R Sampson
Springer-Verlag, New York 1976
214 pages
$14.80



A book that deals with theoretical computing machines, the biology of an amoeba, and a very good checkers program should pique the interest of many readers. *Adaptive Information Processing: An Introductory Survey* is excellent for someone who wants a thorough overview of the subjects covered.

The book deals with three broad topics: information and automata, biological information systems and artificial intelligence. The second and third are at opposite ends of the spectrum of adaptive information processors: living organisms and "intelligent" computer programs that mimic human thought. But the first topic, which deals with the nature of information and with certain imaginary, idealized computing machines, summarizes a body of knowledge that sets an upper bound on the transmission of data and on the problem solving limits of any computer. It is only in the light of these limitations that the later examination of living and nonliving information processing systems becomes meaningful.

The first section has five chapters on communication theory, coding information, finite automata, Turing machines, and cellular automata. The last three subjects refer to three levels of idealized computing machines that mathematicians and computer scientists have devised and studied to determine what problems can and cannot be solved on a given machine. Most important are two facts: firstly, the Turing machine is capable of solving any problem that *any* computer can solve; and secondly, there are certain problems that a Turing machine cannot solve. This implies that there are problems insoluble by computer. The fourth chapter is especially good for its condensation of the work done along these lines, in particular, the famous "halting" problem for the universal Turing machine.

The "Biological Information Processing" section devotes a chapter each to information processors on four levels: the biochemical, genetic, neural, and nervous system levels. The first chapter gives a concise description of the role of enzymes and DNA in the processes of biological information transfer. The fifth chapter deals with limited attempts of scientists to simulate various levels of biological processes via computer programs.

The final section deals with five artificial intelligence topics: pattern recognition, game playing, theorem proving, generalized problem solvers and natural language processing. Here, the author admits that his mate-

rial emphasizes the heuristic programming school of thought, which favors the methods that produce the maximum amount of *intelligence*, rather than those schools that try to model human thought processes. Each chapter in this section describes the terminology, basic concepts, and techniques of the subject. The game playing chapter is useful for readers interested in designing sophisticated game playing programs.

These last chapters describe the most impressive "intelligent" programs in several fields: Guzman's See, which analyzes and recognizes solid geometric forms from a video picture; Samuels' checker playing program, one of the most successful game playing programs; the theorem proving Logic Theorist and the General Problem Solver (both by Newell, Shaw, and Simon); Weizenbaum's Eliza and Raphael's Sir, both written to appear to understand conversational English.

Each chapter ends with a complete bibliography and a short set of exercises. A lot of material is presented in a short space, and the readability of the book varies with the reader's familiarity with the basic concepts of the subject being presented. Except for this one necessary shortcoming, the book still manages to cover some of the most important ideas and programs in computer science history. The section on biological information processing systems augments the book's value.

Gregg Williams
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Memphis TN 38104■

BASIC Programming for Scientists and Engineers
by Wilbert N Hubin
Prentice-Hall Inc, Englewood Cliffs, NJ 1978
$9.95 paperbound

With personal computers currently following a geometric growth curve, I think BASIC will become the Esperanto of the cognoscenti; it nearly is now. Since the professional community forms a large user group, I feel the science and engineering people will need the ability to work in other languages besides the ubiquitous FORTRAN. Mr Hubin's fine book is one of the best first books of BASIC that I have seen. It is suitable for both the experienced programmers seeking to add BASIC to their repertoires, and for the beginning science students who need both computer and technical problem solving experience.

The first portion of the book is devoted to learning the language. The various statements of BASIC are defined and illustrated, and there is a discussion of elementary terminal usage as well as hints for using BASIC in the most efficient manner. Each type of statement has review questions and problems for each subsection, and, for the insecure among us, answers. Hints on troubleshooting are a nice bonus for the newcomer, since it takes a little ACL (accumulated computer lore) before one develops a feel for debugging code. Segments of programs show just how code consisting of BASIC statements can be used to accomplish the reader's purpose.

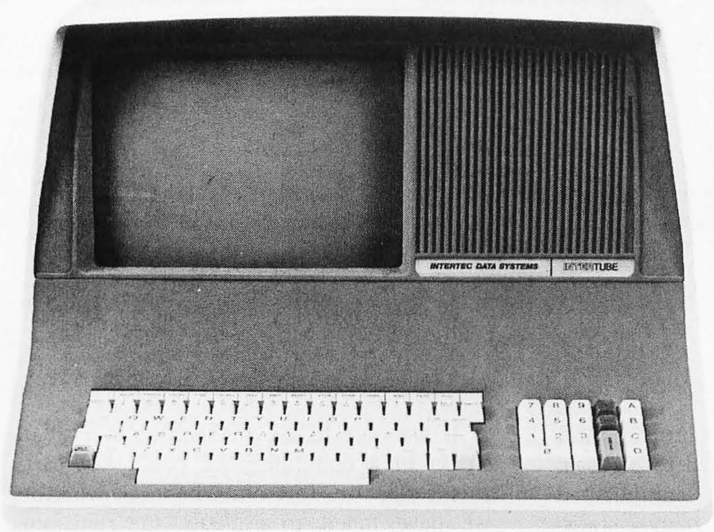
The chapter on flowcharting ably demonstrates the fundamentals of this art, discusses their applications, and then provides a diverse sampling of problems to sharpen the reader's skills. The author's editorial on flowcharting may even bring old hands back to the fold of those who document programs before they become operational. Handily, once again, solution flowcharts are in the appendix.

The concluding two chapters are devoted to solving technical problems with a computer. The problems deserve a mention here, since they form a nucleus of problems suitable for a science course. Equations of motion, centers of mass, Hermite polynomials, and others serve to show the student how to apply the computer to classroom concepts. The range of problems is superb, from simultaneous equations and least squares fit to solutions of differential equations and error analysis. Each application mastered will mean a valuable addition to the reader's skills. The problems are drawn from the gamut of the engineering ranks and the physical sciences, and footnotes refer the reader to the journals of science. Completion of these exercises will give the practitioner a mastery of BASIC and a few fundamentals of science.

The appendices offer a summary of BASIC statements and the meaning of each. There is a short example of terminal usage employing a Digital Equipment Corp PDP-11 as an example. Especially handy is the section on BASIC error messages, although it is a bit brief. In familiarizing yourself with a new machine or language, deciphering the error messages is usually a headache. The computer's opinion of the defects in a program is often expressed in a cryptic manner.

While machines vary, beginners' mistakes do not, and the common ones are listed. In addition, there is a useful index. The bibliography focuses on books applying computers to the physical sciences. Throughout the book, the print is well-displayed and easy to read. If you are thinking of learning BASIC, think of this book.

Noel K Julkowski
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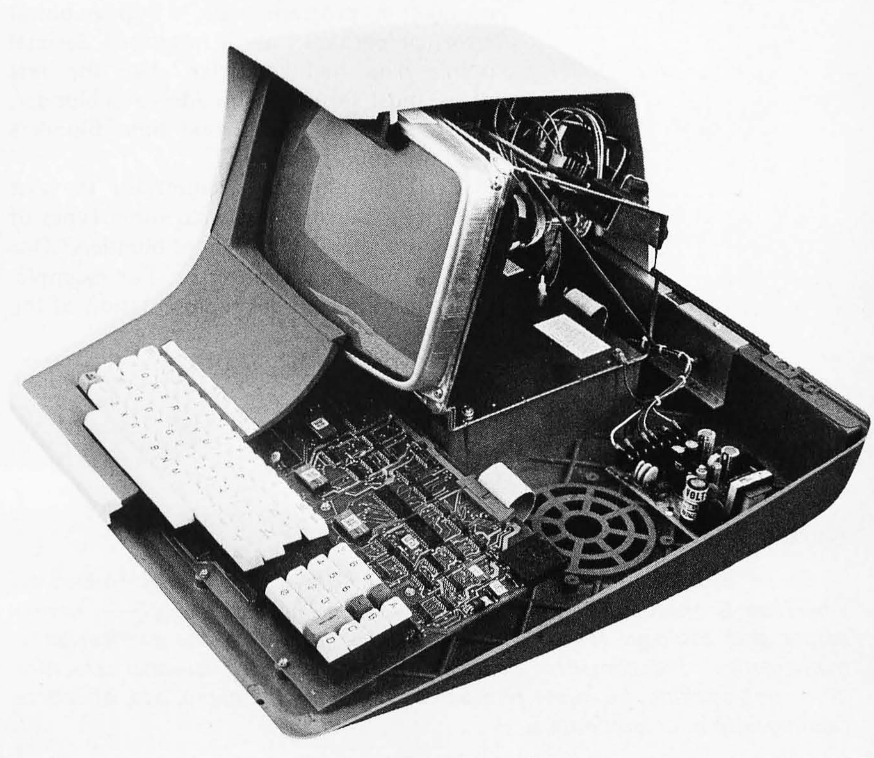
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Sources of Numerical Error

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A growing number of microcomputer enthusiasts are finding the need to perform control operations, evaluate complicated mathematical expressions and analyze statistical data. In short, many hackers want to tackle problems conventionally left to larger computers. To do this, they must become acquainted with error analysis.

Programmers need to be concerned about errors in any program involving the evaluation of a function or algebraic expression, or one which involves a large number of simple but repetitive operations. Even in control applications, it is often critical to be aware of the potential for error.

What do we mean by error? The numerical analyst, a professional mathematician involved with the design and analysis of numerical algorithms, recognizes three distinct types of error. The first is the *blunder*, which is not an error at all in the mathematical sense. A blunder is a gross error: a mistake in program logic, a typographical error, or perhaps only a misplaced decimal point. The mathematician, like the rest of us, must shrug his shoulders at a blunder, and hope to do better next time. Blunders need not concern us here.

Certainly blunders account for the vast majority of errors; but what other types of errors are there if we ignore blunders? One type is the truncation error. For example, take the infinite series representation of the function sin(x):

$$\sin(x) = \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \ldots$$

About the Author

Daniel Buskirk is currently a graduate fellow at Rockefeller University, where he is studying neurobiology. He has a bachelor's degree in mathematics and zoology. His current professional interest is the application of mathematical and computer methods to the study of neuronal structure. When not working, he enjoys photography, playing the piano, and, of course, fiddling with microcomputers.

If we were to use this relation to evaluate sin(x) in a computer, we could not carry this series on forever. Whenever we stop, we have failed to evaluate the remaining terms in the expression, or *truncated* the series. Those who understand a little calculus will recognize that this series *converges;* that is, it gets arbitrarily close to the correct value when sufficiently many terms are calculated. But there must always be a small but finite truncation error (if this computation is carried out on a digital computer).

Another calculation involving truncation error is the evaluation of integrals using the trapezoidal rule. Though an infinite series of trapezoids, each approaching zero width, will give us the area under the curve (its definite integral) exactly, any computer evaluation must settle for a finite number of trapezoids. Thus there will be truncation error. To be sure, it is generally possible to avoid the consideration of truncation error by simply requiring that the truncation error be less than the precision of the whole calculation. However, the clever programmer recognizes that there are usually several different infinite series representations of any function. Often, one of these series will require significantly fewer terms to come within the required precision.

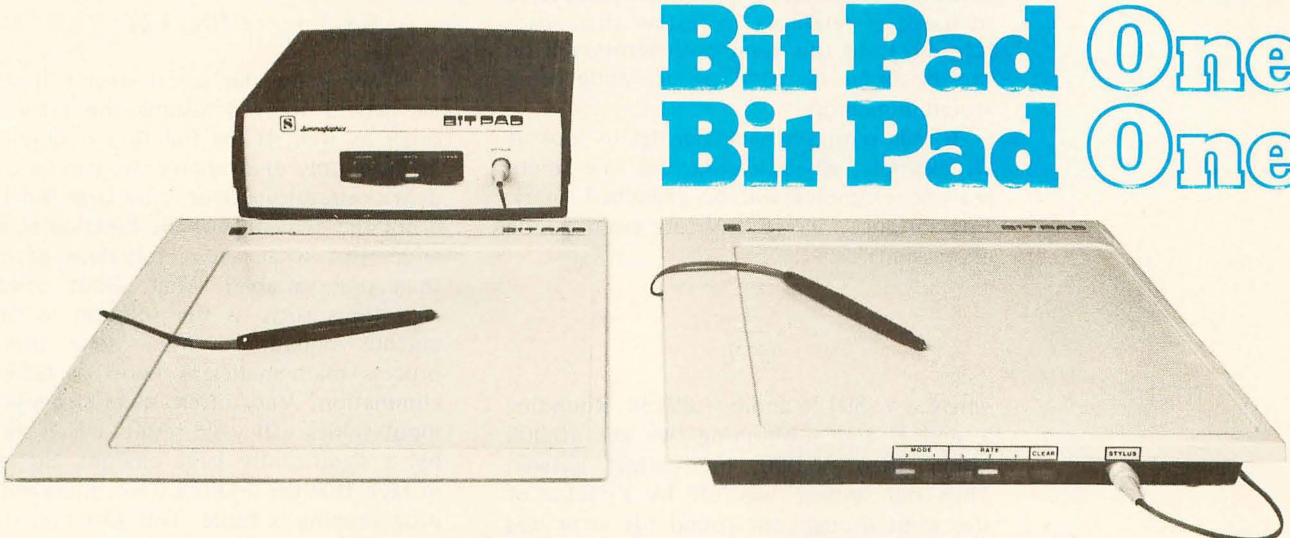
The error of most concern to numerical programmers is not truncation error but rather *roundoff error*. Since the word length in most computers is fixed, any number that exceeds this length must be rounded off before it can be stored in the computer's memory. This error is the most significant, so we shall consider it in more detail.

Although almost all "big" computers store numbers in binary digits, the following examples are given in base ten because it is more familar (and it is similar to the binary coded decimal format often used in microcomputer floating point packages).

Most computers store a real number by breaking it down into a mantissa and an exponent, much like scientific notation. A word which looks like this:

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$$\boxed{7352}\quad\boxed{05}$$

mantissa exponent

would represent the real number 0.7352 x 10^5 or 73520. Now, if we wish to store a number larger than four decimal places, we must round it off. (It is true that our exponent here is limited to two decimal places. Any exponent with three or more places in this case represents an *overflow* condition. Since overflow is generally easily avoided, we will not discuss it here.) Consider the numbers 8,931,724 and 0.761253. In the first case, rounding off to 0.8931 x 10^7 represents an error of 724. The error in rounding the second is 53 x 10^{-6}. Thus, it is most common for the numerical analyst to speak of relative error rather than absolute error. In this case, both errors will be on the order of 10^{-4} of the value being stored in memory.

If this error seems trivial, let us look at an example, albeit a contrived one (more realistic examples will be examined later). For instance, if we wish to evaluate the expression:

$$\frac{1}{a-b}$$

where a = .89136 and b = .89134. Rounding a and b and subtracting, we get 10,000 rather than 50,000, the correct answer. Thus our answer was off by a factor of five even though our round off error was very small. It might be argued that double precision calculation would have eliminated the problem completely. Clearly, accuracy increases with increased word length, but roundoff never disappears. Since some hand calculators use up to 13 decimal digits in storing numbers while displaying ten digits, we might expect them to have "more than enough" accuracy. But in many engineering and statistical problems, calculators can make significant errors. The reader concerned with calculator accuracy might wish to read the short article by Bernard Cole in the November 25 1976 issue of *Electronics.*

The reason for the problem with roundoff, even with 13 digit accuracy, is the situation most frustrating for numerical programmers. Roundoff occurs at every step of any program. In a very long program, roundoff error may have been introduced many millions of times. This error may propagate itself and accumulate into a very large error in the result. Programs in which this propagation of error is likely to occur (finding the inverse of a large matrix, for instance) are generally so complicated that it is impossible to predict precisely what the effect of constant rounding off will be. Often the numerical analyst resorts to probability theory to get an idea of how much error is likely to be in the results.

Errors often become critical when functions are calculated. Let us assume we have a value for the variable x stored in memory. There is some error associated with x (perhaps roundoff error, or maybe x is the result of a physical measurement). We'll call this error δ. Thus $x = x_0 + \delta$, where x_0 is the unknown true value of x. It may be very easy to calculate some function of x, f(x), but what is the error of the result? Let us define the error of the result as ϵ. Then:

$$f(x_0) + \epsilon = f(x_0 + \delta)$$

If we know our initial error δ is small, we would like to assume the error ϵ is small as well. If the function is simple, or involves only one variable, we can be confident the resulting error is not large if neither δ nor the derivative of the function at x_0 is large. But what about functions of more than one variable? What about complex algorithms such as the solution to simultaneous equations, often done using a process mathematicians know as Gaussian elimination? Very often, small errors in the input values will yield results which are off by a significantly large amount. So large, in fact, that the results are worthless and the programming is futile. This situation is distressingly common in everyday problems in science, engineering and the social sciences. Numerical analysts call a problem *well posed* if small errors in input still result in a reliable answer. However, even a well posed problem can be solved inaccurately if the programmer has not chosen his algorithm cautiously.

With all this talk about errors, what can be done? Is there any hope at all of obtaining consistently reliable results? Unfortunately, there are no general methods. However, the programmer who is aware of how errors can occur is in a better position to compensate for them. For instance, let's look at the general quadratic equation:

$$x^2 + 2bx + c = 0$$

[Note: *The expression on the left side of this equation is equivalent to the familiar form used to generate the quadratic formula,* $ax^2 + bx + c$. *However, it leads directly to the computationally simpler form of the two roots* X_1 *and* X_2 . . . CM]

If we have a computer of word length t, we might reasonably hope to solve for x by using the formulas

$$x_1 = -b + \sqrt{b^2 - c}$$

$$x_2 = -b - \sqrt{b^2 - c}$$

These formulae work well in most cases, but the astute programmer should notice that there is a problem if $b < 0$ and

$$\frac{|c|}{b^2} < 10^{-T}.$$

In that case:

$$x_2 = -b - \sqrt{b^2 - c}$$

will give an erroneous result. A programmer who tests for this condition can then calculate the correct result simply, using the relation

$$x_2 = c/x_1$$

For another example, consider the experimenter who wishes to record the temperature of his home hourly, 24 hours a day, and print out the average of the last 24 readings (perhaps he also wants to execute some control operation based on this average). Being inclined toward efficiency, this fellow decides that after having added 24 readings for the first average, for each of the succeeding averages he need only add the newest reading and subtract the oldest from his running total, rather than read all the readings every hour. What might happen here is that small errors which occur during the arithmetic are never disposed of and can accumulate without any upper limit. Perhaps the error might eventually become as large as the measurement itself! If this programmer were not quite so "efficient" and calculated using the last 24 readings each hour, the error would be, at most, 24 times the error for each data point.

Folk wisdom claims, "There's more than one way to skin a cat." Likewise, there's more than one way to do most calculations. A+B−A does not always equal B to a computer. Algebra tells us that A(B+C) = AB+AC, but again, the computer sometimes disagrees. It is the programmer's responsibility and challenge to understand his algorithms and to choose them wisely. The reward for the trouble is results he can trust!■

REFERENCE

Ralston, Anthony, *A First Course in Numerical Methods*, McGraw-Hill, New York, 1965.

Technical Forum

A Comparison of Bar Code Encoding Schemes

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The purpose of this article is to compare some of the encoding schemes which might be used for bar code software. The three most important characteristics of an encoding scheme are:

- Packing efficiency: how many data bytes per printed page.
- Vulnerability to wand speed changes and other timing errors.
- Number of storage bytes required for timing information, assuming post read processing of timing data.

Other less important factors include human readability and the constancy of DC output level.

Three methods have previously been defined in "A Proposed Standard for Publishing Binary Data in Machine Readable Form," by Walter Banks and Carl Helmers, November 1976 BYTE, page 10: bar width modulation (format 1), ratio recording (format 2), and fixed gap bar width modulation (format 3). The other schemes listed in table 1 include frequency modulation (FM), phase encoding (PE), nonreturn to zero inverted (NRZI), synchronized nonreturn to zero inverted (SNRZI), modified frequency modulation (MFM), group coded recording (GRC) and zero modulation (ZM).

In phase encoding (PE), a 1 is represented by a transition from white to black and a 0 by the opposite transition. Additional transitions are added to account for successive 1s or 0s. The frequency modulation (FM) encoding method provides a transition in either direction at every bit boundary, and an additional transition to mark each 1. The resulting code is very similar to that created by the phase encoding method, since both provide timing information at least once per bit.

The nonreturn to zero inverted (NRZI) encoding scheme generates a black to white (or vice versa) transition for every 1. The absence of a transition denotes a 0. This method has the disadvantage that no timing information is generated during a string of 0s. The synchronized nonreturn to zero inverted (SNRZI) method adds a 1 to every byte to guarantee at least one piece of timing information per byte. If the redundant clock transitions are eliminated from the frequency modulation code, the number of transitions per bit is halved, doubling the possible density of data for a given minimum module width; this is modified frequency modulation (MFM).

Zero modulation (ZM) and group coded recording (GCR) are modifications of the nonreturn to zero inverted method which are designed to guarantee timing information at least once every two or three bits, respectively. In group coded recording, each 4 bit

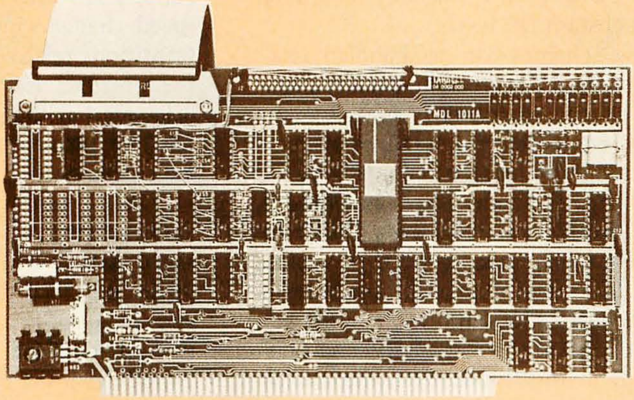
Table 1. Comparisons of various encoding schemes. Overheads such as parity and sync bytes were not included in the packing density calculations. The maximum timing bytes per data bit were determined assuming perfect bar codes and do not allow for such problems as dirty bar codes.

	Packing density		Timing tolerances			Memory requirement
Encoding scheme	Average data bit duration ("modules")	Data bytes per page	Absolute timing tolerance ("modules")	Wand speed tolerance	Constant DC level	Maximum timing bytes per data bit
Format 2	3	1170	0.5	25%	No	2
Format 3	2.5	1400	0.5	25%	No	2
FM/PE	2	1750	0.5	25%	Yes	2
Format 1	1.5	2330	0.5	25%	No	1
NRZI	1	3500	0.5	6%	No	1
SNRZI	1.125	3100	0.5	10%	No	1.125
MFM	1	3500	0.25	12.5%	No	1
GCR	1.25	2800	0.5	16.7%	No	1.25
ZM	1.125	3100	0.25	12.5%	Yes	1.125

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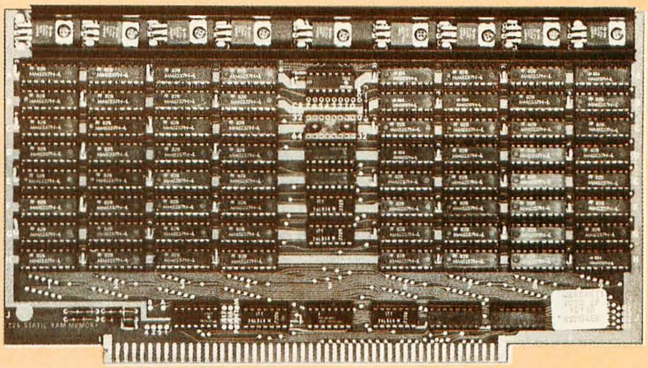
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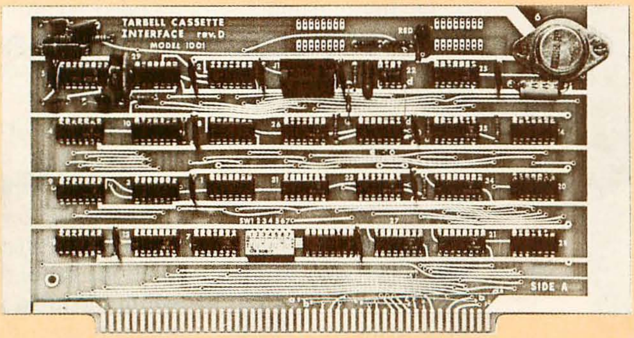
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unit of data is mapped into a unique 5 bit word chosen to assure no more than two consecutive 0s. In zero modulation each bit is mapped into two bits and the result encoded in nonreturn to zero inverted format. The net result is comparable to that provided by group coded recording with the advantage, useful in the magnetic recording field, of a constant DC level.

All these schemes can be handled relatively simply in software. The deciding factor should be made on other grounds.

Table 1 compares the number of data bytes which can be printed on an 8.5 by 11 inch (21.6 by 27.5 cm) page, assuming a narrow bar width of 0.014 inches (0.04 cm) and a line to line spacing of 0.15 inches (0.38 cm). Several of the methods listed will provide between 2500 and 3500 bytes per page. Since packing density is not particularly critical in this application, the choice should be made on the basis of the remaining and crucial criterion: vulnerability to wand speed changes and other timing errors.

It is in this area that the requirements of hand held optical reading diverge from those of machine driven magnetic recording. In the magnetic recording field, short term variations of the relative velocity between the medium and the head are held to a minimum. The designer's main concern is with the absolute value of the permissible phase error; ie: the amount by which timing error may apparently move a transition before playback errors occur. The speed of a hand held wand may vary widely from place to place on the data track. In this case we are concerned with the permissible percent speed change which can occur between two transitions relative to the average speed over the previous few transitions. This may be calculated as the percentage ratio of the permissible phase error to the maximum time which can occur between transitions.

Table 1 expresses the timing tolerance of each scheme in terms of the permissible speed change and the absolute timing error. Since the modified frequency modulation and zero modulation methods have to distinguish between bars which are 1, 1.5 and 2 modules wide, they are both twice as sensitive as the others to absolute errors such as printing tolerances, and may be rejected for bar code printing for this reason.

The choice between the remainder may be made on the basis of a compromise between packing density and speed tolerance. The percent speed variations listed in table 1 are permissible only in the ideal case, in which printing tolerances and other timing errors are zero. In real life, short term consistency of wand speed is more critical than table 1 makes it appear to be. ASCII code printed by the nonreturn to zero inverted method can have eight successive zeros, even if the null character is not permitted. This leads to a very low speed change tolerance. The synchronized nonreturn to zero inverted method reduces the number of consecutive zeros to five by introducing an extra 1 per byte. Nevertheless, the speed tolerance is still low and both methods may be eliminated for this reason.

Of the remainder, group coded recording has the greatest packing density, by 20 percent, but the others have a 50 percent greater tolerance to speed variations. It is questionable whether the software complication and lower speed tolerance of group coded recording are worthwhile in this application.

This leaves frequency modulation, phase encoding, bar width modulation, ratio recording and fixed gap bar width modulation as alternatives. All these methods have the same speed and absolute timing tolerances. The choice may be made on the basis of packing density. The bar width modulation method comes out far ahead of the other methods. Bar width modulation is the logical choice for the encoding of printed software intended for recovery by a hand held light wand.■

Technical Forum is a feature intended as an interactive dialog on the technology of personal computing. The subject matter is open-ended, and the intent is to foster discussion and communication among readers of BYTE. We ask that all correspondents supply their full names and addresses to be printed with their commentaries.

BYTE's Bugs

Puzzling Machine Language Puzzler

The "Machine Language Puzzler" in BYTE January 1979, page 52 was very interesting. However, I must disagree with the author's detailed analysis of how the program works. It is a CALL FFFD instruction located at address FFFD which repeatedly calls itself, pushing a return address of 0000 on the stack, until all of memory is zeroed including the program itself.

Let's take a detailed look at what happens after memory locations 0001 through FFFC have been zeroed. First, the CALL FFFD instruction is fetched from locations FFFD, FFFE, and FFFF. This causes the program counter to be loaded with FFFD, and 0s are written into locations 0000 and FFFF. At this point the CALL instruction has been changed to a CALL 00FD, but the program does *not* yet branch to address 00FD as stated. The next instruction is still fetched starting at address FFFD, since the CALL FFFD was fetched from memory *before* location FFFF changed from FF to 00. Now the CALL 00FD is fetched, 0s are written into locations FFFE and FFFD, and the program starts executing NOPs at address 00FD. Note that no NOPs are executed at all until all of memory has been zeroed.

In the case where memory only exists at addresses 0000 to 00FF and FF00 to FFFF, operation of the program is very complex. It proceeds as above through zeroing *all* existing memory and branching to a NOP at 00FD. When the FF (RST 7) is executed at location 0100, a 0101 is pushed on the stack at locations FFFC and FFFB. Memory continues to fill up with 0101s until a 01 is written at location 00FF. Starting at this point the return address pushed on the stack may be 0101, 0102, or 0103 depending on whether the RST 7 is executed at 0100, 0101, or 0102. Remember that one or two bytes of FF may be read as data of a LXI B, *data* instructions. The program ends up executing a complex sequence of LXI B, STAX B, and INX B instructions in a loop starting at address 0038 and ending with a RST 7 instruction at 0100, 0101, or 0102. The program will keep changing itself as the stack wraps around forever.

It is still an interesting program. The net effect, in the first case, is still the same. I wonder if a similar program that zeros out all of memory including itself exists for other microprocessors as well?

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Smart Memory Part I

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About the Author

Randy Smith is employed by Semionics Associates as the design engineer for the REM S-100 board and is the coinventor of REM. His personal interests include artificial intelligence research, especially language comprehension.

There is a useful distinction being made today between two types of display terminals: so-called "dumb" terminals perform the necessary functions of data reception, transmission, and display. Their *intelligent* counterparts, however, are capable of performing sophisticated data manipulations on their own, relieving the host processor of some of the routine burden. The same distinction could be drawn from memory systems. In most machines the memory component forms a passive blackboard: its function, the principal one of any memory, is to remember. Yet memory systems can be built which take a more active processing role.

What kinds of things could a *smart memory* do? The normal random access memory has unique addresses for its cells, and an address must be provided to read or write information, one cell at a time. The concept of *address* or *location* as a necessary attribute of content may be difficult for beginning programmers to grasp. A far more palatable idea to the human thinker is that words, shapes, or sounds serve to "call up" the information associated with them.

Suppose we distribute some intelligence throughout our special memory system, animating it by changing each memory word into a *demon*. These demons are jumbled about together in a darkened cave, and their principal characteristic is that they recognize when they are being spoken about. Aside from that, they are rather lazy, working only when standing up, and sitting down for a snooze at the earliest opportunity. For example, our demons might represent inventory information for a hardware store.

> "Alright, everybody on your feet!"
> (Otherwise nobody would pay attention.)
>
> "I want anyone who knows anything about hammers."
> (There is a resounding thud as all sorts of appliance demons, chainsaw demons, etc sit down and resume their naps.)
>
> "Specifically, ball-peen hammers."
> (Claw hammer and jackhammer demons drop out, leaving, in this example, one solitary demon.)
>
> "How many do we have on hand?"

We did not need to know where the demon was who answered us. A reply to our query emanated from the mouth of the cave. We don't even know how many demons lurk inside — since all demons work simultaneously, we got our answer in a time independent of their number. Consider what this means for information retrieval: if the preceding "program" takes N microseconds for a file of 10 inventory items, and the file grows to 10,000,000 items, the processing time required is still N microseconds. Therein lies one of the most tantalizing aspects of a memory system like this — adding more information (more memory) *improves* system performance:

- More items are processed in the same time;
- There are no address space saturation or segmentation problems, since addresses are not used — a single bit signal (on/off) can distinguish accesses to this memory from normal addressed memory requests.

A memory having qualities like those just illustrated is called an *associative memory* or CAM (*content addressable memory*). Not too surprisingly, associative computer memories in varying forms have been proposed many times before. The reasons why people

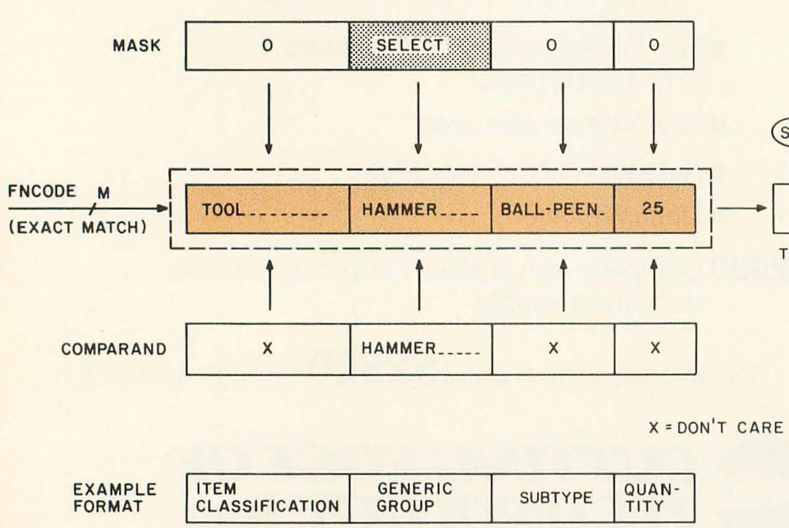


Figure 1: An example of full word parallel information retrieval.

LASTNAME	FIRSTNAME	JOB	AGE	SEX	HAIR	EYES	LASTRAISE	ETC	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
—	—	ENGINEER	45	F	BLD	BL	—	—	1	1	0	0	0	0	0	0	0	0
—	—	SECRETARY	33	F	—	—	—	—	1	0	0	0	0	0	0	0	0	0
—	—	—	—	—	—	—	—	—	1	0	0	0	0	0	0	0	0	0
JACKSON	SUE	—	—	—	—	—	—	—	1	0	0	0	0	0	0	0	0	0
—	—	JANITOR	50	M	—	—	8/78	—	1	0	0	0	0	0	0	0	0	0
—	—	MANAGER	—	F	—	—	—	—	1	0	0	0	0	0	0	0	0	0
JONES	MIKE	ENGINEER	38	M	BR	BR	—	—	1	1	1	1	1	1	0	0	0	0
—	—	—	—	F	—	—	—	—	1	0	0	0	0	0	0	0	0	0
—	—	ENGINEER	41	M	BR	BL	—	—	1	1	1	0	0	0	0	0	0	0
—	—	—	—	—	—	—	—	—	1	0	0	0	0	0	0	0	0	0
JETER	BOB	ENGINEER	27	M	BR	BR	5/78	—	1	1	1	1	1	1	1	1	1	1

(1) SET
(2) JOB = "ENGINEER"
(3) HAIR = "BR"
(4) EYES = "BR"
(5) LASTNAME = "J??????"
(6) AGE > 25
(7) AGE < 30
(8) SEX = "M"
(9) READ(LASTNAME,FIRSTNAME)
(10) READ(LASTRAISE)

Figure 2: When selecting a final response, check that one of the response bits is still set after all questions have been asked and answered.

(including the author) "reinvent" the concept with some regularity are twofold: the descriptions of this form of memory rarely make it past technical parallel machine architecture symposia or journals into the more commonplace world; and the beauty and power of a memory that can by its very nature eliminate or ease searching, sorting, table lookup, and pattern matching is so striking–the idea is so natural in human terms that it occurs to many individuals.

Figure 1 shows a conceptual associative memory word holding information from the previous example. It can be seen that a long word is desirable to store related data. Exact match was the only comparison function used (and is the basic, sometimes only, associative function available in the integrated circuit forms of this memory). A mask is applied to all the words and selects the part of the words to be treated (either matched against, or read out). The *comparand* is the common information that all words test. Due to the length of associative words, some real designs compare the words with the comparand one bit at a time (bit serial, word parallel). This reduces the amount of comparison logic and the size of the data paths to reasonable levels, although a full word comparison takes longer.

Comparisons are usually over lengths much less than the full word size, so the compromise is a good one. With each word there is one separate bit of information for the response status, called the *tag*. The SET function forces the tags to their responding state (1), thereby activating all words initially. A good survey of associative memory articles and architectures is found in Yau and Fung. There is also a new, easy to follow book on the subject by Foster (see bibliography). The full word parallel design of figure 1 will be used for the examples, since it is the simplest conceptually. A more practical architecture that can be built for an S-100 computer will be outlined in part 2.

Selection

More intelligence can be added to our demons.

"Everybody up!"
(1) SET — Load personnel file from diskette.

"Who, in my employ, — an engineer, brown hair and eyes,
(2) JOB = "engineer"
& (3) HAIR = "br"
& (4) EYES = "br"

last name "J . . . " something, between 25 and 30 years old — has been dating my daughter?"

Text continued on page 58.

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Text continued from page 55:

& (5) LASTNAME = "J???????????"
& (6) AGE > 25
& (7) AGE < 30
& (8) SEX = "m"

"Has he had a raise lately?"
(9) READ(LASTNAME, FIRSTNAME)
(10) READ(LASTRAISE)

Figure 2 shows another example of information retrieval, this time with a personnel file, and again with a single demon finally selected. Response of the demons is shown after each step. Any of the relational comparisons as well as exact match can be added easily to the function set. Information has been broken down into fields and field lengths the user deemed most valuable. Since this word format can be stored on floppy disk with the data, the driving program or operating system has easy access to it and can manipulate the mask to select the field requested for each operation. A *top level* program could be as utterly readable as the one given with the example. So far, only the first step in utilizing information in the associative memory has been illustrated — the selection process. The overall set of entries is logically reduced by selection criteria to the subset of interest. Members of the smaller set may now be updated in parallel, or read out (in part, if desired) on some priority basis; the former involves parallel writing of the associative words, and the latter, responder resolution (when there is more than one answer).

Multiwrite

Now that the demons we want are on their feet, what kind of work can they do besides checking their description? They can all be told to change it at the point specified by the mask (ie: all responding words can be made to change their values at once to the value on the comparand bus). This process of writing a common datum, in parallel into all responding words, is called multiwrite responders by Foster, and he calls associative memories possessing this ability CAPPS (content addressable parallel processors). Whole sets of items can be updated (eg: marking certain bills as paid), or, if the selection criterion is known to produce a unique result, more specific information can be written (change John Q Williams job title to manager).

Again, we can be sending these associative write commands into the interior of a dark cave. We know which demons are reacting, but we don't know *where* they are, nor do we care. The nearest use of address information occurs when the mask is changed to operate on a specific field (whose relative location inside each word has been previously established).

By setting the mask to enable the writing of only a single bit (or bits), parallel program *flags* can be kept with each word, recording the word's membership in some selected group, with the flag itself possibly becoming

Command	Action
(1) SET	Activate all words.
(2) MW FL1,FL2,FL3,FL4,$0F_{16}$	Initialize all four flags at once.*
(3) ADD LASTMO TO STD	STD←STD + LASTMO for all words.
(4) REGION = 'W'	Select western region salesmen.
(5) STD > 100	
(6) MW FL1,0	FL1 = 0 marks the members of this group with sales to date over $100,000.
(7) SET	
(8) REGION = 'E'	
(9) STD > 75	
(10) MW FL2,0	Eastern region salesmen with sales to date over $75,000.
(11) SET	
(12) REGION = 'C'	
(13) STD > 50	
(14) MW FL3,0	Central region salesmen with sales to date over $50,000.
(15) SET	
(16) FL1,FL2,FL3 = 111_2	All salesmen not included in the three*
(17) MW FL4,0	subsets above have FL4 = 0.
(18) SET	
(19) FL4 = 1	The union of the three subsets
(20) QUERY	Any members left in this set?
(21) JUMP Z, (26)	Transfer to statement 26 if not.
(22) READ(LASTNAME,FIRSTNAME)	
(23) PRINT(LASTNAME,FIRSTNAME)	Read the specified fields of the first responder and print them.
(24) NXT	Turn off first responder (select next
(25) JUMP (20)	one).
(26) END	

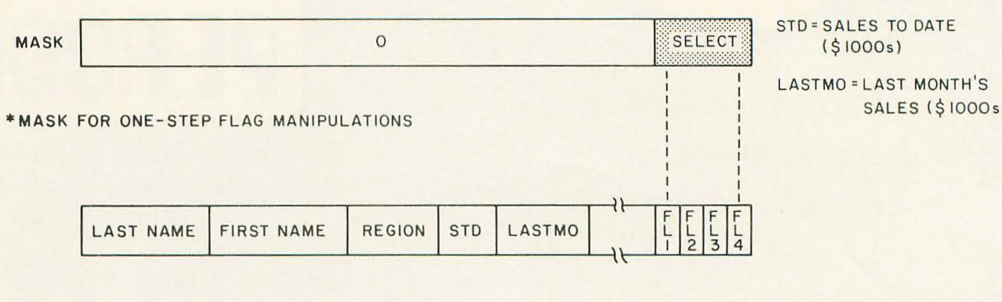
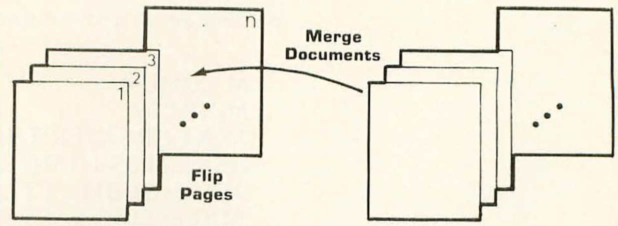


Table 1: A complete information processing example with parallel update, and the use of disjunctive sets.

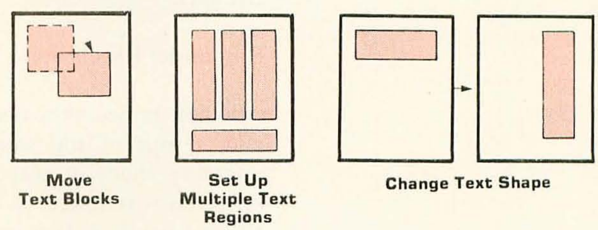
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Power

- **Page Oriented Philosophy.** A document is a collection of pages. The screen displays one entire page at a time. Simple random access page flipping commands take you quickly to any page in the document. Equally efficient commands allow you to insert, delete, copy and move pages both within one document and across documents.



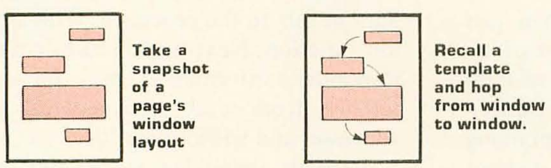
- **Extensive Block Manipulation Capabilities.** Using "windows", portions of text, charts, etc., can be quickly and effortlessly moved around on the current page, or across pages. The shape and size of any window can be changed in real time, with the contained text automatically reformatting itself (heeding word and paragraph boundaries) to conform to the new shape.



- **Instantaneous Formatting.** Compacting (extraneous blank deletion) and right justifying are simple commands that tidy up a full page or window's worth of text in the blink of an eye. Random access cursor movement, line and character insert and delete, line and page split and join, and a host of other line and character level commands help you put text in its place quickly and accurately.

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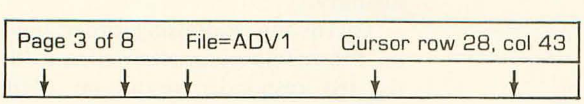
- **Logical/Physical Page Distinction.** Define your own hardcopy size. Wordsmith remembers the difference between the screen size and the hardcopy page size.
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- **Auto Word Break.** Forget the right margin. Wordsmith notices when you won't be able to complete the current word and moves it to the next line for you as you continue typing.
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part of future selection criteria. Alternatively, these flags might be used to save carry or overflow information during parallel arithmetic routines. Indeed, combining these program variables with further comparison sequences makes possible a whole list of parallel associative routines like:

MAXIMUM
MINIMUM
NEXT GREATER THAN
NEXT LESS THAN
ADD or SUBTRACT constant
ADD or SUBTRACT fields
STRING SEARCH (pattern matching)
SORT on any field.

Figure 3 demonstrates the method of flagging responding words, table 1 shows a complete information processing example with parallel update, and the use of disjunctive sets.

Responder Resolution

When it becomes necessary to get information out of the words rather than just updating them in place, some form of arbitration is required to handle cases of multiple responders. It is useful to have a *query* function to tell if there are any responding words. "Is anybody in there?" Any demons sitting down and asleep would not answer, and any amount of simultaneous yes replies would still be interpretable. In fact, any answer at all, except total silence, indicates there is at least one responder. A single, readable bit line on which each word ORs its tag (responder = 1) would tell the central processor whether or not any active words were left. (With some analog hardware we might even count the number of responders by measuring the intensity of the answer.)

It is not acceptable to walk to the mouth of the cave and yell inside, "I want the name of anyone who speaks French." If only one standing demon meets this *requirement*, the answer you hear will be true, but in general you may expect to be greeted with an unintelligible mixture of voices. To handle the problem, a priority list can be implemented at the hardware level. All words in the system are daisy-chained together to one word arbitrarily defined as having the highest priority. When an associative read is executed, a small amount of time is allowed for the chain to select the highest priority responder, and that responder alone is enabled to place its requested field(s) on the data in bus to the processor. With a companion function, Next, which turns off the first responder, information may be extracted serially from each active word without addresses and without conflict.

Without addressing, we are able to do the following: select via content those words we want (in parallel); process them in place (in parallel); and read out their information (serially).

Entering data into an associative memory initially is a serial operation, so provision is often made for random access addressing. With absolute fixed addresses, associative memory may be quickly loaded from secondary storage or main memory through DMA (direct memory access) or block transfers. Random access reads and writes are both allowed. To save address space when using this addressable associative memory, the memory may be arranged into banks occupying the same locations. Random access memory requests affect only the addressed memory section whose bank is selected; associative instructions ignore bank information and activate the whole memory.

Given the addressing order now placed on the memory, an alternative to the priority list responder resolution hardware is available. The tags of words sequential in address space may be blocked into groups and fed to the central processor as data from special input ports or memory locations. The processor can then scan the bits in order for 1s (responders). Since tag N represents word N in the associative mem-

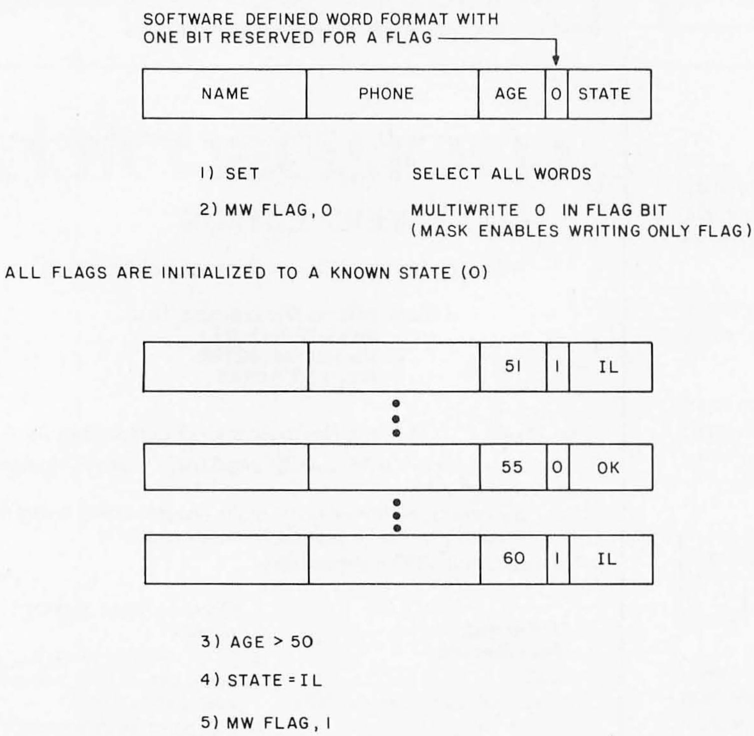


Figure 3: Multiwriting allows the user to write data into all locations that are responding at the same time.

Color. VP-590 add-on Color Board allows program control of 8 brilliant colors for graphics, color games. Plus 4 selectable background colors. Includes sockets for 2 auxiliary keypads (VP-580). $69.*

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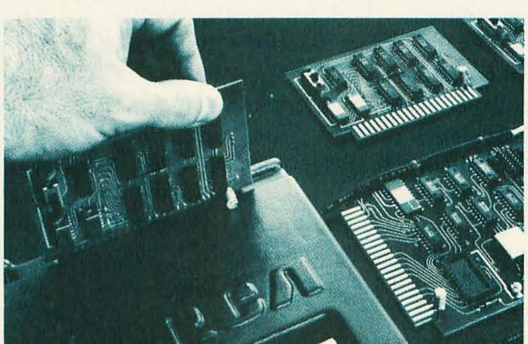
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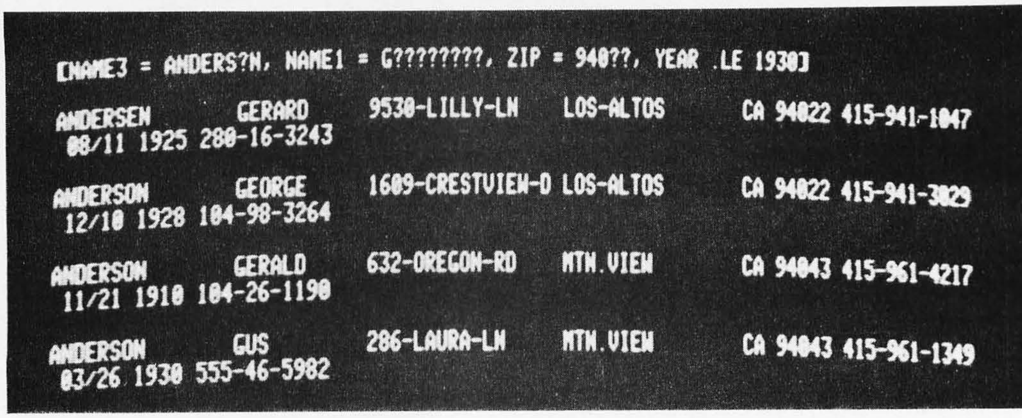


Photo 1: Video display of an inquiry to Semionics' associative memory board, REM, and the response. In the inquiry, ? is a don't care character which will match anything.

ory, an absolute word address can be derived and information read random access style.

The accessing of data via address makes this second responder resolution technique nonassociative, but it is sometimes used to avoid the extensive hardware of the priority list.

The Real Time Pinch

When the first generation of computers was being built, hardware was critically expensive, and the von Neumann architecture — a general purpose design which truly minimizes hardware through serial processing — was not seriously questioned. With the plummeting cost of electronic parts, minimizing hardware has become less important to the designer. The desire to maximize throughput, particularly in multiuser situations, has led to the introduction of parallel processing at all architectural levels with the concomitant increase in hardware complexity — from multiprocessor systems, to machines incorporating multiple independent I/O (input/output) channels, down to distributed processing logic, as in an associative memory. The concept of a general purpose parallel computer is quite hazy, so the thrust has been to build specialized hardware for the von Neumann machine to deal with the parallel components of computing as they are recognized.

Some products for associative processing are commercially available. On the high end, STARAN is a very expensive associative machine from Goodyear Aerospace, and may be the only machine of its kind for sale. On only a slightly less grand level, there are a few 16 bit or smaller CAMS (integrated circuit associative memory integrated circuits), which even in quantities of 100 carry a price tag of about $1.50+ per bit. They are fast parts, some with speeds in the 10 to 40 ns range. IBM also uses such fast, and small associative memories in the virtual memory hardware of the 360/67 for quick address lookup. But associative memory for a large computer subsystem need not be nearly so fast, nor could it be tolerable at such a price. Cost, in the world of electronics, is not necessarily a function of complexity, but of volume.

Unfortunately, large manufacturers must usually see millions of projected sales before entering the marketplace with anything really new. Big businesses, meanwhile, cannot afford to walk away from years of accumulated software on their present machines, no matter how cumbersome. Software is expensive to create and maintain, so big installation inertia will keep sales volume at a trickle. Yet given the ubiquity of sorting, searching, merging, updating, and linking in such business systems, it is no small irony that a judiciously used associative memory subsystem could in many cases greatly reduce software complexity, and therefore expense (not to even mention greatly increase program speed). To review, costs will not come down, nor viable products become available until expected sales volume goes way up, and at $1.50 per bit. . . .

The cycle, representative of large scale business, may perhaps be broken at the new grass roots level — the home, small business, or research system where inertia is at a minimum. An add-in associative memory can be designed with off-the-shelf integrated circuits and random access memories for a cost to memory ratio of only 2 or 3 to 1. This memory design is discussed in part 2 (May 1979 BYTE).

BIBLIOGRAPHY

1. Foster, Caxton C, *Content Addressable Parallel Processors,* Van Nostrand Reinhold Co, New York, 1976.

2. Yau, S S and Fung, H S, "Associative Processor Architecture — A Survey," *Computing Surveys,* volume 9, number 1, March 1977.■

"Micro-Computer Products to Look Up to"

NorthStar Gazer

Horizon Disk Capacity Keeps Growing

The Horizon is now capable of 720K bytes on-line! The Horizon can connect to four double density 5¼" single-sided disk drives. Each of those drives can access 180K bytes of information. A four drive system accesses 720K bytes!

That's capacity you don't usually find in a microcomputer, but there's even more to come! The North Star disk controller board is designed so that two-sided disk drives may be added as soon as they become available from North Star.

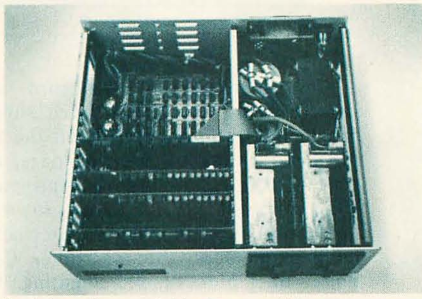
Existing Horizons will accommodate the new two-sided drives so North Star owners can simply add additional drives to up-grade their system. Each two-sided drive will access 360K bytes! That means the maximum on-line disk storage for the Horizon will increase to over 1.4 **million** bytes!

New Cabinet for Disk Drives

North Star additional disk drives are now available with the same high quality wood cover as the Horizon computer! The Additional Drive Cabinet (ADC) is designed to accept either one or two drives for the Horizon or for mounting North Star Micro Disk System drives. Like the Horizon, the ADC is available with either wood or blue metal cover. Included is a new power supply capable of powering one or two drives. The ADC is $129 in kit form. Assembled, with one drive the ADC is $599, with two drives $999.

Pascal Now Available for Horizon

The much-heralded Pascal language is now being offered for use with the North Star Horizon computer. North



Inside view of Horizon with processor board, RAM board, disk controller, two drives, and power supply.

Star, with the co-operation of the University of California at San Diego, is now delivering a Pascal Program Development system. North Star Pascal is ideally suited for developing large programs because of features such as: long variable names, block-structured control statements, and compilation. North Star Pascal is available on 5¼" diskettes for use with the Horizon or Micro Disk System. North Star Pascal will operate with either the Z80 or 8080 microprocessor.

Pascal, including documentation, is available in either single or double density versions for $49.

An auxiliary Pascal diskette, containing an 8080/Z80 assembler and some additional Pascal utilities, is available for $29. Complete information is available at your local retail computer store.

First Double Density, Now Double Memory

The new North Star 32K RAM board (RAM-32) has doubled the memory density of the popular Horizon computer. Available either with the Horizon or other S-100 bus computers, the RAM-32 runs at full speed—no wait states—with the 4 MHz Z80A microprocessor (as well as with slower Z80 and 8080 processors). Addressability of the RAM-32 is switch-selectable in four 8K regions.

North Star RAM features like bank-switching and parity checking are standard. The parity checking capability means that the RAM-32 is constantly diagnosing itself. That's a plus for your system. The fact that parity checking is a North Star RAM-32 standard is a plus for your pocketbook! There is no extra charge for this important capability.

A Horizon with 48K of RAM can be configured by using one North Star 16K RAM board and a RAM-32. Need more memory? 56K can be configured by using two RAM-32 boards with one 8K region switched off.

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Horizon - 1-32K	1849	2099
Horizon - 2-32K	2249	2549
RAM-32	599	659
RAM-16	399	459

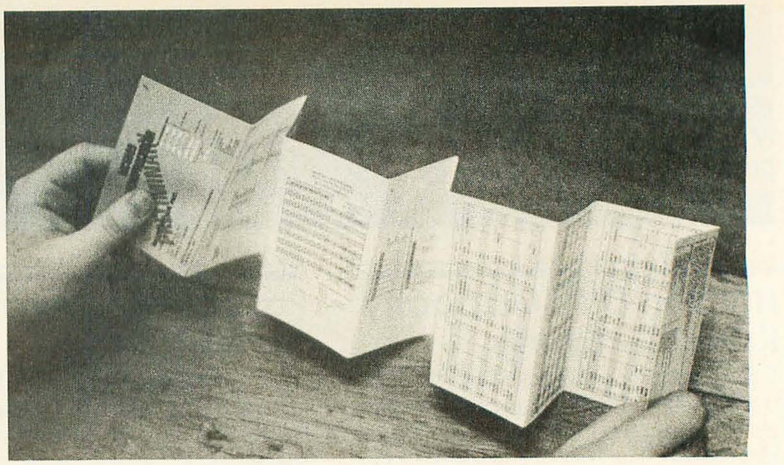


◀ A typical Horizon configuration: CRT, Horizon computer, Additional Drive Cabinet (ADC).

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Circle 285 on inquiry card.

BYTE's Bits



Motorola 6809 Card Folding

A useful item of documentation furnished with the Motorola 6809 microprocessor is the *MC6809 Microprocessor Instruction Set Summary* card. Printed on heavy stock, it contains vital information for the programmer in condensed form. This combination of heavy stock and condensed information gives this document an information density of 4.72×10^7 characters per slug, a figure imaginable only with advanced technology.

Users who peruse the card, however, might have difficulty in refolding it to its original compact configuration. Therefore we present here helpful instructions to refold the card.

The first step is to differentiate between the pages of the card. Luckily, this is much easier than integrating between the pages, or even reading between the lines. Here we employ the convention of using letters of the English alphabet. Upper case is preferred for clarity, but lower case may be employed if you are coding a word processing system.

Completely unfold the card and stretch it out on a flat surface. Using a pencil, inscribe the letter A on the top righthand corner of the first page, the page containing the title and programming model. Move the pencil down to the second page, and inscribe the character B in the top righthand corner. Continue this process, incrementing the alphabetic character down the length of the card until you reach the last page, which should bear the appellation J. This completes the page distinction routine.

Having identified the pages, you are now ready to begin the actual folding process. Grasp the bottom page J. Fold it up on top of page 1. Now take page I, and fold along the F-G seam so that the back side of page I contacts the back side of page D. Take care that page J does not become unfolded from I.

Take heart, we're almost through. Grasp the top edge of page G and fold along the C-D seam so that the front side of page G contacts the back side of page A. Moving quickly now, fold the front side of page C to the front side of page B. Take the A-G aggregate, and fold the whole thing back onto page E. The folding process should now be complete, and the card returned to its original state.

User options at this point include: placing the card in your pocket, placing the card in a desk drawer, or binding the card with a paper clip.

Note please, that these instructions are based on preliminary folding information provided by Motorola. It is possible that actual production sample of the card will have a different foldout specification.

In addition to its unique topological properties, the card will be of interest because of the information printed on it. Included are addressing mode summaries, operation descriptions, register bit assignments, vectors and stacking order, and miscellaneous data. . . .RS ■

NE Computerized Bulletin Board

We have received an announcement from the New England Computerized Bulletin Board System informing us that they have been in operation since December 1977. In order to connect to the CBBS, a terminal with a modem or acoustic coupler and a phone line is necessary. The procedure is as follows: set your terminal to 300, or 110 bps (30 or 10 characters per second) full duplex. Dial (617)963-8310 and wait for the carrier. Place the phone in the acoustic coupler and hit carriage return on your terminal a few times. The CBBS will then respond and take you the rest of the way.■

Circle 351 on inquiry card.

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A Simulated View of the Galaxy

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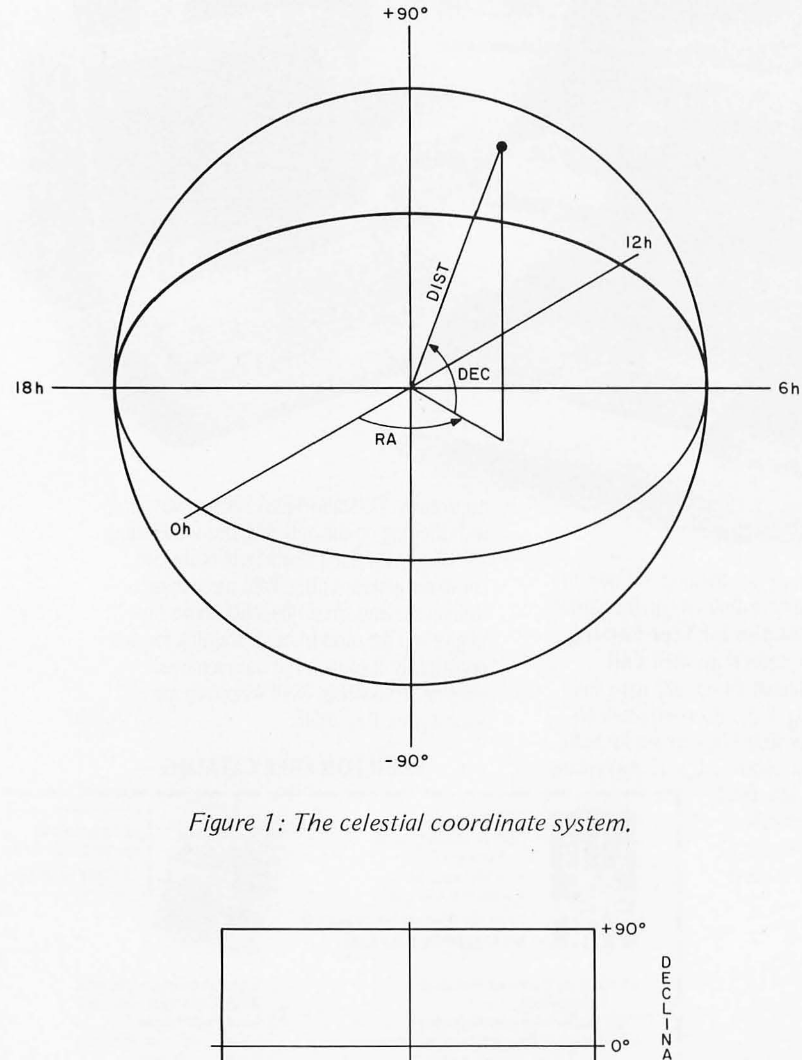


Figure 1: The celestial coordinate system.

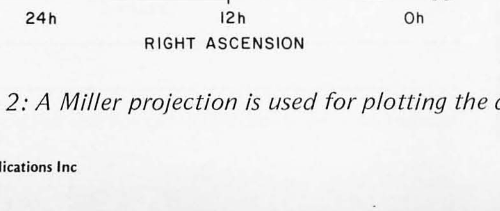


Figure 2: A Miller projection is used for plotting the data.

At one time or another, each of us lets our imagination wander; perhaps to places familiar to us, or places we have never been and can only dream about exploring. Often, my imagination leads me to the questions: "What does our sun look like from neighboring stars?" and "What do our familiar constellations look like from other points of view?" Have you ever wished that you could travel anywhere in the universe whenever you wanted to? With the help of computers and graphics displays we can begin to answer some of these questions and have fun exploring what we know about the galaxy at the same time.

Getting Started

Several things are needed to simulate the stars in our galaxy; an algorithm that will allow us to shift our position with respect to the Earth based coordinate system; actual or hypothetical coordinates of stars; and a display device on which to plot the resulting star maps. The first version of this program was written four years ago and run on an IBM 1130 computer. Output was in the form of a printer plot. 50 stars were entered, using data on the 50 brightest stars in our sky. Since positions given in star catalogs are in celestial (spherical) coordinates, right ascension (RA) corresponding to longitude (0 to 23 hours), declination (DEC) corresponding to latitude (–90 to +90 degrees), and distance in light years were entered directly into a disk file. The program then performed the necessary conversions to get values in radians. Figure 1 shows the celestial coordinate system.

The author wishes to thank TRC Photographic Specialists of Omaha NE for their help.

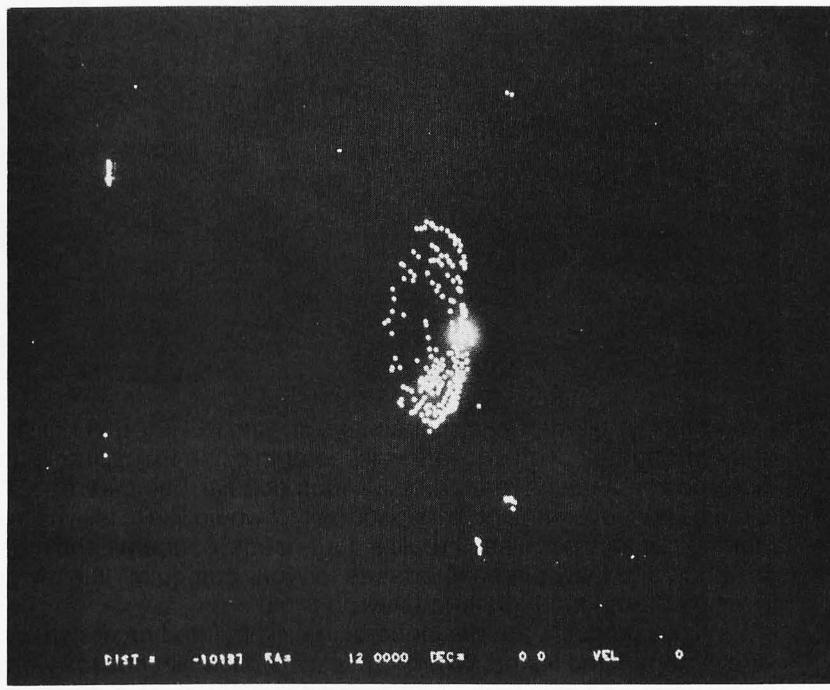


Photo 1: Side view of our galaxy from 90,987 light years.

Coordinate Transformations

In order to display the stars as they would appear from another point in space, their coordinates must be converted to a manageable form. Shifting the origin of the coordinate system appears to be the easiest way to obtain the desired results. Declination and right ascension must be converted to radians first:

$$RA = RA \times 0.261799$$
$$DEC = DEC \times 0.01745$$

where RA and DEC represent right ascension and declination, respectively. Then the celestial coordinates can be converted to rectangular coordinates:

$$X = R \times \cos(DEC) \times \cos(RA)$$
$$Y = R \times \cos(DEC) \times \sin(RA)$$
$$Z = R \times \sin(DEC)$$

The resulting rectangular coordinates are in units of light years, because of the variable R (distance). The coordinates may be kept in three arrays for easy manipulation.

Next, the origin must be shifted to the new point of view. The celestial coordinates of the destination or new origin are given by the user of the program (through console input) and converted to rectangular coordinates with the same set of equations used above. To shift the origin, the following three equations should be used:

$$X' = X - X_0,$$
$$Y' = Y - Y_0,$$
$$\text{and } Z' = Z - Z_0,$$

where X_o, Y_o, and Z_o are the rectangular coordinates of the new origin; X, Y, and Z are the old coordinates of a star in the three arrays; and X′, Y′ and Z′ are the resulting shifted coordinates.

To display the stars, the rectangular coordinates must be converted back to celestial coordinates:

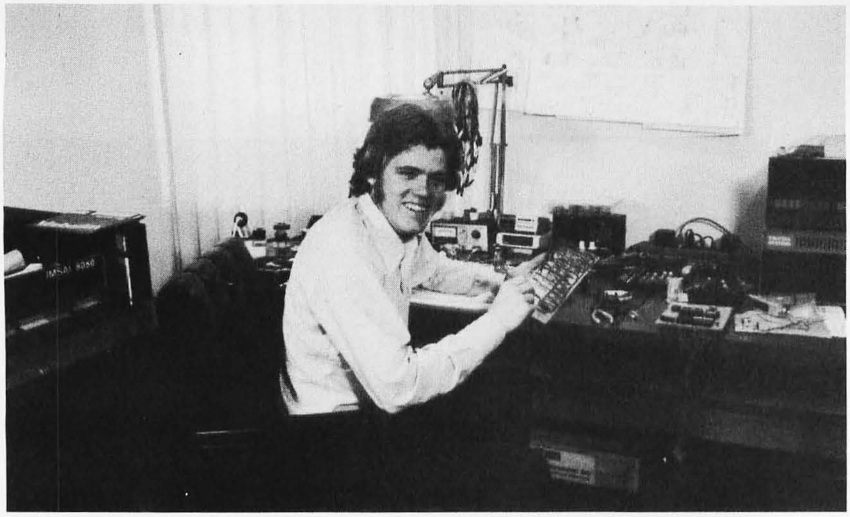
$$(R')^2 = (X')^2 + (Y')^2 + (Z')^2,$$
$$RA' = \arctan(Y'/Z'),$$
$$DEC' = \arcsin(Z'/R').$$

It is also necessary to multiply by the appropriate scale factors to be compatible with the screen or window dimensions of the display device. The current version of the program displays the stars in the form of a Miller projection, as shown in figure 2. This produces a distorted view on the top and bottom of the display but does show the entire sky. An alternate format magnifies the window to display only a 50 by 50 degree frame. This gives the impression of looking out the window of a spaceship, but makes navigation difficult.

In order to shift the window, we must introduce some new variables to indicate in the program which rotations are required. This can most easily be accomplished by altering the equations used for shifting the origin:

Text continued on page 70

A glossary is provided on page 80.



HELLO FELLOW COMPUTERIST...

At this time I wish to introduce myself. I am PERRY POLLOCK, the owner, manufacturer and designer of the products advertised in this issue of this fine magazine. In the issues to come, I will be introducing more powerful interfaces for the various popular computers.

To take advantage of this opportunity, I would like to tell you a little about my beliefs, aims and policies. Starting out as a hobbiest, I realize your needs, concerns and most of all the requirements of a good, well designed and fairly priced interfaces for your computer. It is my goal to supply you with the most for your investment and the highest quality possible.

All the products are designed by me. They are first drawn out and logically analyzed. Then they are wire wrapped and tested. When I am satisfied that it functions well, then I will etch a sample printed circuit board, then and only then, will I commit the design to a mass production run.

All the parts used in our products are of the highest quality. The manuals are written so you can understand all the phases of construction and operation. How many times have we bought a product and it lacked for a good, understandable manual, or has it had so many flaws that we could swear that we were re-designing the product. ALL OF THIS IS IN THE PAST. These products are not offered unless they are right!!!

Another one of my aims is to let you know who you are dealing with. How many times have we ordered a product and wondered who we were really dealing with. Then . . . if we had problems, how difficult was it to contact them? Because of all this, I have chosen to publish a picture of myself (I'm not vain, really) and a picture of my wife Korrine (pictured below). I am available 24 HOURS A DAY. I have a telephone answering service that will put your call through to me anytime day or night, or if you wish you can call me at home. (602) 886-5037. If you have a problem, question or just want to talk, give me a call.

I have many exciting new products under development. It will be an exciting year and I hope you will enjoy the interfaces designed for you and I. I know these interfaces have made my computer more enjoyable for me and hopefully for you.

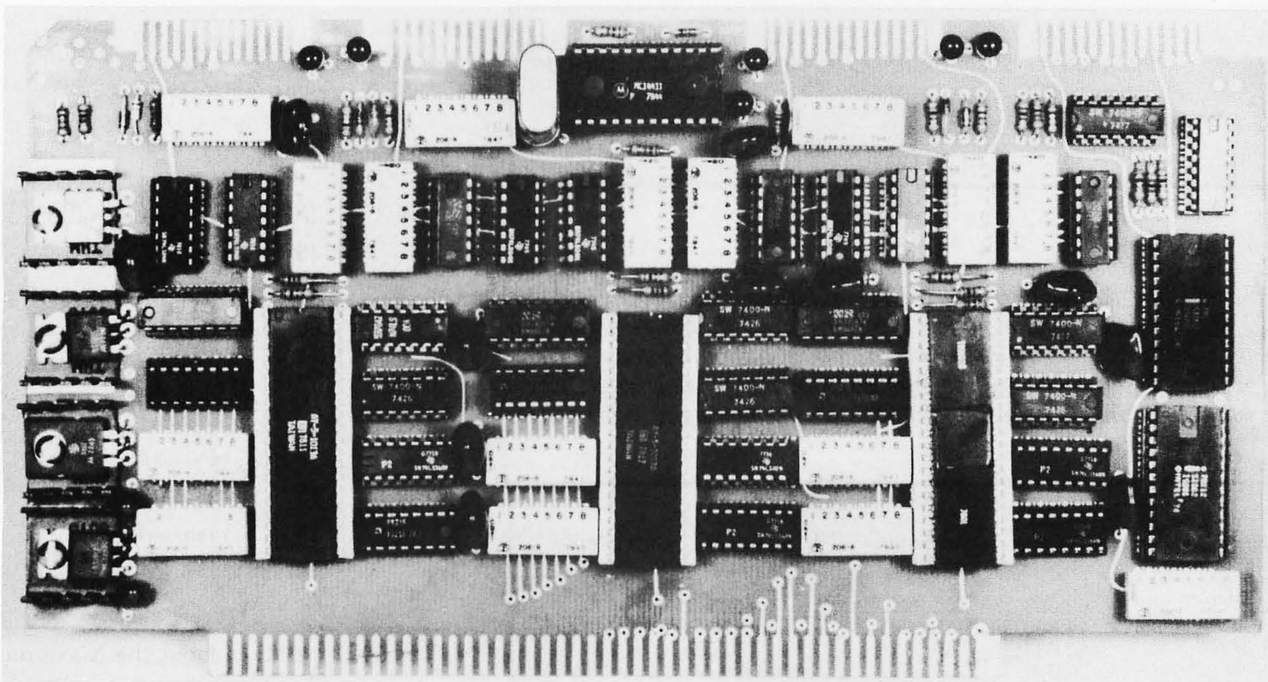
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- **SOFTWARE COMPATIBLE:** The 3 S+P will be compatible with most software arrangements due to the ability to set the status bits and the parity. Parity, character length, stop bits all set by dip switches. Each port can be set to it's own individual arrangement.
- **HIGH QUALITY:** The highest quality parts are used. P.C. Board is with plated through holes, solder mask, silk screen legend and gold plated contacts.
- **OUTPUT ARRANGEMENT:** All outputs terminate at the top of the card via a 26 contacts. Standard 26 pin IDC connectors mate with each port. RS-232, current loop at each serial port and full data lines at the parallel port connection. Operation is asynchronous mode, but can be configured for synchronous operation by minor re-configuration.
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Table 1: Execution times of one iteration of the program with various numbers of stars. Times include plot or display device data transfer rates.

Number of Stars	IBM-1130	8080/BASIC	8080/ASM	IBM 370/158
10	4 minutes	10 seconds	0.5 seconds	0.1 seconds
100	6 minutes	100 seconds	5.0 seconds	0.3 seconds
400	8 minutes	400 seconds	20.0 seconds	1.0 seconds

Table 2: Star coordinates taken from star atlases and catalogues. Besides using real stars, the author also input 300 "imitation" stars to fill out the galaxy to what it actually looks like. The stars listed should be enough to produce interesting patterns in a reasonable amount of home computer time. Names (popular or scientific) are rough approximations in English alphabet. An asterisk represents ficticious "fill-out" stars to represent extragalactic objects.

Name		Right Ascension (hrs)	Declination (degrees)	Distance (light yrs)	Magnitude
A. CETUS		02.983	003.900	250.0	2.8
A2. LIB		14.800	−15.833	62.0	2.9
THI. ERI		02.933	−40.517	120.0	3.4
SUN		00.000	0.000	.1	−9.0
AND.GALAXY		00.667	4.100	1500000.0	7.8
AND. A		00.668	4.100	1500000.0	7.8
AND. B	*	00.666	4.200	1500005.0	7.8
AND. C	*	00.665	4.400	1500010.0	7.8
AND. D	*	00.668	4.300	1501000.0	7.8
AND. E	*	00.667	4.500	1500100.0	7.8
AND. F	*	00.660	4.000	1500150.0	7.8
AND. G	*	00.656	4.400	1500050.0	7.8
AND. H	*	00.660	4.550	1510000.0	7.8
AND. I	*	00.661	4.500	1510001.0	7.8
AND. J	*	00.667	4.600	1510000.0	7.8
EG224A		00.667	041.001	1500000.0	5.0
EG224B	*	00.669	041.000	1500000.0	5.0
EG224C	*	00.665	041.001	1500000.1	4.9
EG224D	*	00.666	041.002	1500001.0	5.0
EG224E	*	00.665	041.001	1500000.0	5.0
EG224F		00.668	040.999	1500000.0	5.0
EG225COMP		00.630	041.420	1500000.0	9.9
EG201COMP		00.667	040.600	1500000.0	9.5
PLEIADES		03.733	023.950	4300.0	4.7
SIRIUS		6.716	−16.6	8.7	−1.4
A.CENTAURI		14.600	−60.6	4.3	−.2
CANOPUS		6.380	−52.6	2300.0	−.7
VEGA		18.586	38.733	23.0	.1
CAPELLA		05.216	045.950	42.0	.2
ARCTURUS		14.223	019.450	32.0	.2
PROCYON		07.612	005.350	10.0	.5
ARCHERNAR		01.598	−57.483	70.0	.6
B CENTAURI		14.005	−60.133	130.0	.8
ALTAIR		19.805	008.733	18.0	.9
ALDEBARON		04.550	016.416	54.0	1.1
SPICA		13.376	−10.900	190.0	1.2
FORMALHAUT		22.915	−29.883	27.0	1.3
DENEB		20.662	045.100	465.0	1.3
RIGEL		05.202	−08.250	545.0	.3
BETELGEUSE		05.875	007.400	300.0	.9
BELLATRIX		05.367	006.300	230.0	1.7
E. ORION		05.567	−01.233	300.0	1.7
K. ORION		05.767	−09.683	2100.0	2.2
D. ORION		05.497	−00.333	600.0	2.5
L. ORION		05.550	009.917	1600.0	3.7
ANTARES		16.438	−26.316	170.0	1.2
REGULUS		10.095	012.216	70.0	1.3
B. LEO		11.800	014.733	43.0	2.2
G. LEO		10.300	019.983	90.0	2.6
E. LEO		09.733	023.917	100.0	3.1
TH. LEO		11.217	015.600	150.0	3.4

Table 2 continued on next page.

Text continued from page 67

$$X' = X - X_0,$$
$$Y' = Y - Y_0,$$
$$\text{and } Z' = Z - Z_0,$$

will become:

$$X' = (X - X_o)(\cos\phi)(\cos\theta) + (Y - Y_o)(\sin\theta)(\cos\phi) + (Z - Z_o)(\sin\phi)$$

$$Y' = (Y - Y_o)(\cos\theta) - (X - X_o)(\sin\theta)$$

$$Z' = (Z - Z_o)(\cos\phi) - (X - X_o)(\cos\theta)(\sin\phi) - (Y - Y_o)(\sin\theta)(\sin\phi)$$

where:

θ = rotation about the X axis on the Y,Z plane,

ϕ = rotation about the Z axis on the X,Y plane.

Also, when converting back to celestial coordinates, scale factors must be introduced to produce a 50 by 50 degree field of view. The user may wish to experiment with other window formats.

Expanding the Model

Looking at the sky from various points of view in space is interesting, but I have found that animation really shows the power of the simulation technique, and of animated graphics. With the coordinates of over 400 stars (100 real stars *and* 300 that add the general shape of the Milky Way spiral arms of our own galaxy), we can begin the exploration of our universe. Unfortunately, 400 stars do not make a galaxy, or even a small

About the Author

Mark Dahmke is currently employed by the University of Nebraska Computer Network as a programmer/analyst in the Academic Computing Services section. He is also a senior computer science major. At home Mark owns an 8080 based system with 32 K bytes of memory and a floppy disk drive. His work involves graphics, electronics, writing and systems programming.


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Table 2, continued:

D. LEO	11.217	021.000	140.0	3.5
Z. LEO	10.250	023.567	500.0	3.6
M. LEO	09.850	026.167	110.0	4.1
R.D SCO	15.900	−28.500	450.0	4.0
SCO	16.883	−42.317	300.0	3.8
TH. SCO	17.567	−42.967	140.0	2.0
SHAULA	17.500	−37.067	200.0	1.7
E. SCO	16.783	−34.200	75.0	2.3
K. SCO	17.650	−39.000	360.0	2.5
D. SCO	15.938	−22.533	590.0	2.5
G. SCO	16.883	−42.317	100.0	3.8
POLLUX	07.705	028.150	31.0	1.2
CASTOR	07.523	032.000	44.0	1.6
E. GEM	06.700	025.167	200.0	3.2
GEM	06.217	022.517	300.0	3.4
D. GEM	07.300	022.033	300.0	3.5
Y. CAS	00.900	060.450	200.0	2.2
A. CAS	37.833	059.267	230.0	2.4
B. CAS	00.108	058.883	45.0	2.4
D. CAS	01.400	060.083	150.0	2.8
E. CAS	01.867	063.517	100.0	3.7
D. TAURUS	05.383	28.567	130.0	1.7
TAU	05.633	021.000	350.0	4.1
HYADES	04.250	016.000	300.0	4.0
E. TAU	04.450	019.117	300.0	4.0
E URSAE MAJ	12.863	056.233	50.0	1.7
DUBHE	11.000	062.017	105.0	1.9
N. UMA	13.767	049.467	210.0	1.9
MIZAR	13.367	055.183	190.0	2.2
D. UMA	12.233	057.200	100.0	2.2
B. UMA	10.980	056.650	76.0	2.4
Y. UMA	11.867	053.967	88.0	2.5
B CRUCIS	12.746	−59.416	465.0	1.5
A CRUCIS	12.396	−62.816	150.0	1.6
E CANIS MAJ	06.945	−28.900	325.0	1.6
ACRUX	12.400	−63.150	220.0	.9
E. CARINA	08.358	−59.350	330.0	1.7
B. CARINA	09.217	−69.517	300.0	1.8
A. TRIA	16.717	−68.933	130.0	1.8
MIRFAK	03.350	049.683	270.0	1.9
Y. VEL	08.133	−47.183	100.0	1.9
ALHENA	36.583	016.450	78.0	1.9
KAUS. AUST	18.350	−34.417	160.0	1.9
AL WAZOR	07.100	−26.317	650.0	1.9
MURZIM	06.342	−17.933	300.0	1.9
D. VEL	08.717	−54.517	70.0	2.0
ALNITAK	05.633	−01.967	400.0	2.0
B. AURIGAE	05.933	044.950	84.0	2.0
PEACOCK	20.367	−56.900	160.0	2.1
POLARIS	01.817	089.033	470.0	2.1
Y. UMI	01.530	073.000	500.0	4.7
N. UMI	01.620	076.000	700.0	5.7
D. UMI	01.795	086.100	650.0	5.0
E. UMI	16.850	082.130	550.0	5.1
TH. UMI	01.572	078.100	750.0	5.0
A. OPH	17.550	012.600	67.0	2.1
NUNKI	18.867	−26.367	160.0	2.2
A. AND	00.088	028.817	120.0	2.1
ALPHARD	09.417	−08.433	200.0	2.2
AL NA'IR	22.083	−47.200	91.0	2.2
SUHAIL	09.100	−43.233	220.0	2.2
B. PER ALGOL	03.082	040.767	100.0	2.2
A. ARI	02.067	023.233	74.0	2.2
B. GRUS	22.650	−47.150	325.0	2.2
B. CETI	00.683	−18.267	57.0	2.2
B. UMI	14.850	074.367	270.0	2.2
I. CARINA	09.267	−59.067	100.0	2.2
TH CENT.	14.067	−36.117	86.0	2.2
D. PUPPIS	08.033	−39.867	800.0	2.3
Y1. AND.	02.033	042.083	400.0	2.3
ALPHECCA	15.550	026.883	67.0	2.3
Y. CYGNUS	20.333	040.100	470.0	2.3
B. AND	01.117	035.350	75.0	2.4
Y. DRA	17.917	051.500	150.0	2.4
N. CMA	07.367	−29.200	270.0	2.4
A. PHE	00.400	−42.583	76.0	2.4
E. PEG	21.700	009.650	250.0	2.5
A. PEG	23.033	014.933	100.0	2.6
N. OPH	17.125	−15.667	76.0	2.6
Y. CRV	12.217	−17.267	130.0	2.8

fraction of it, but with a little imagination (which was all we had in the first place) we can mentally fill the gaps in the model. The current version of the simulation runs on an IBM 370-158 with a 2250 graphics display unit. The 2250 has a resolution of 4096 by 4096 points. With a slight modification to the program, it will run in a continuous loop, starting with a direction vector and velocity in light years per iteration. The effect is that of a space craft with almost unlimited velocity. With a fast processor, the impression of speed is dramatic. Velocities of 10,000 light years per second have been simulated. There are no relativistic effects, but it might be interesting to add the necessary equations—especially if color graphics are available. The Doppler shifts would be most striking. The stars in the direction of travel would be intensely blue, while those receding from the observer would be a deep red.

Adding More Stars

As my desire to travel outward increased, I soon realized that I would have to have something to travel to. Additions to the model included the Andromeda galaxy (approximately 1.5 million light years away), the Magellanic clouds (our nearest intergalactic neighbors) and several other extragalactic objects. One problem with adding more stars is that the execution time goes up proportionately. When experimenting with computer based simulations, this soon becomes apparent. Note that in listing 1, the algorithms have been optimized to the extreme, to cut down on the execution time. Comparison tests were run on several systems with the results shown in table 1.

The IBM-1130 was slowed down by its printer, used to generate a printer plot of the star map. The 8080 is almost fast enough to compete with the 370, if it didn't have to do the floating point calculations in software. A floating point hardware board would probably decrease the times given for the 8080 by a factor of 10. The 370 is a multiprogramming system—running several other programs at the same time. Thus, the simulation has to compete with other programs and is also slowed down by competition for peripheral devices such as video terminals, the 2250 graphics display, printers, and card readers.

Implementation

The details of implementation depend on the computer, display device, and language used. The original IBM-1130 version used a printer plot because that was the only out-

put device available. Since the available memory was limited (8 K words), the program was written to make heavy use of disk files for storage of the starting coordinates and intermediate results. The last phase of the program scanned the disk file containing the shifted coordinates and produced a printer plot.

The second version ran on an IBM/360-65 and plotted on a Tektronix 4013 graphics display terminal. Although neither of these first two versions was animated, single star maps could be obtained.

The 2250 version required considerably more programming effort. Since the 2250 is a high speed device, true animation was finally possible. The 2250 refreshes its display from a core buffer loaded from the processor. Coordinates are plotted and mapped into the buffer; subroutine EXEC is then called and the entire buffer is sent to the display. Unfortunately the buffer must be cleared before another iteration can take place—but clearing the buffer also clears the screen. The solution is to maintain two separate buffers. One can be displayed on the screen while the other is being cleared and loaded. If this is not done, the display will flicker with a duty cycle of about 10 percent on, 90 percent off, since the calculation time is greater than the intermediate display time.



Photo 2: Our galaxy from —5983 light years.

Sample Output

Photo 1 is a side view of our galaxy from 90,987 light years. As you can see, the model is not accurate because the middle of the galaxy is almost empty. Also, the large bright spot on the right side of the galaxy represents the tight group of 100 stars that form our local constellations. At the bottom of the screen distance, right ascension, declination, and velocity have been displayed for reference. The minus sign on the distance means that the direction of travel is opposite the direction the right ascension/declination vector. Photo 2 is a view of our galaxy from -5983 light years. Photo 3 shows the sky from Earth (note the Big Dipper in the upper center, Leo just above and right of center, and the Milky Way down the left side and across the bottom). Photo 4 shows our local constellations from 2937 light years, against the background of the Milky Way. Photo 5 is another side view of the Milky Way from one million light years (viewed with the 50 by 50 degree window). The two small objects just below and to the right of the galaxy are the large and small Magellanic Clouds. They are approximately 100,000 light years from the Milky Way.



Photo 3: The night sky as seen from the Northern Hemisphere of Earth. Note the Big Dipper in the upper center, Leo just above and right of center, and the Milky Way down the left and across the middle.

Text continued on page 80

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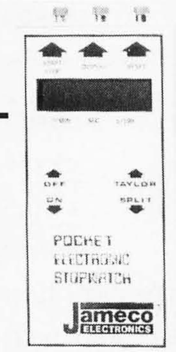
SWITCHES CRYSTALS CONNECTORS HEAT SINKS FUSEHOLDERS TEST CLIPS BOOKS KITS DIP JUMPERS CABLE ASSEMBLIES SWITCHES CRYSTALS CONNECTORS HEAT SINKS

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★ Uses MM5314 clock chip
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★ 115 VAC operation
★ 12 or 24 hour operation
★ Includes all components, case and wall transformer
★ Size: 6-3/4" x 3-1/8" x 1-3/4"

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JE747

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INTEGRATED CIRCUITS MICROPROCESSOR LED'S SOCKETS CAPACITORS DIODES TRANSISTORS RESISTORS POTENTIOMETERS

Circle 201 on inquiry card.

```
      DIMENSION FX (400), FY(400), FZ (400)
      REAL NRA, NDEC, NEWR

C     READ IN AND STORE RECTANGULAR COORDINATES FOR STARS IN FX,
C     FY, AND FZ ARRAYS.

      DO 1 I = 1, 400
              READ (5, 100) CRA, CDEC, CDIST

C     FIRST, CONVERT CRA, AND CDEC TO RADIANS

              CRA  = CRA  * .261799
              CDEC = CDEC * .01745

              CXY   = DIST * COS (CDEC)
              FX (I) = CXY * COS (CRA)
              FY (I) = CXY * SIN (CRA)
              FZ (I) = DIST * SIN (CDEC)
    1         CONTINUE

  100 FORMAT ( 3( 10F7.3) )

C     RA, DEC, AND DIST REPRESENT THE POLAR COORDINATES FOR THE
C     DIRECTION VECTOR. VEL IS THE VELOCITY OR RATE OF CHANGEOVER
C     EACH ITERATION OF THE ALGORITHM.

      DIST = 0.
      RA   = 3.1415927
      DEC  = 0.
      VEL  = 0.

C     ADVANCE THE DISTANCE COUNTER BY ADDING THE VELOCITY FOR ONE
C     ITERATION.

   10 DIST = DIST + VEL

C     NOW COMPUTE THE NEW LOCATION IN SPACE FROM RA, DEC, DIST.

      AXY = DIST * COS (DEC)
      AX  = AXY * COS (RA)
      AY  = AXY * SIN (RA)
      AZ  = DIST * SIN (DEC)

C     NOW ENTER THE INNER DO LOOP WHERE THE SHIFTED COORDINATES
C     ARE FOUND, CONVERTED TO CELESTIAL COORDINATES AND PLOTTED.

      DO 20 I = 1, 400

              XP = FX (I) - AX
              YP = FY (I) - AY
              ZP  = FZ (I) - AZ

              NRA   = ATAN (YP / XP)
              NEWR = SQRT (XP * XP + YP * YP + ZP * ZP)
              NDEC  = ARSIN (ZP / NEWR)

C TEST FOR QUADRANTS MESSED UP BY THE ARCTANGENT FUNCTION.

              IF  (XP .LT. 0.) NRA = NRA + 12.
              IF ((XP .GT. 0.) .AND. (YP .LT. 0.)) NRA = NRA + 24.

C TEST FOR SCREEN LIMITS.

              IF (NRA .GT. 24.) NRA = NRA - 24.
              IF (NRA .LT. 0.  ) NRA = NRA + 24.

C PLOT POINTS HERE, USING THE APPROPRIATE SUBROUTINE CALLS FOR THE
C AVAILABLE DISPLAY DEVICE.

              CALL P POINT ( -NRA, NDEC)

   20         CONTINUE

C     CLEAR SCREEN; PREPARE FOR NEXT ITERATION.

C     TEST FOR CONSOLE INPUT; CHANGES IN DIRECTION, VELOCITY, SCREEN
C     WINDOW FRAMING, ETC.

      GO TO 10

      STOP
      END
```

Listing 1: Generalized FORTRAN version of galaxy simulation. This program can be converted almost directly into BASIC. Note: for those people not having an arcsin function: arcsin function: arcsin (x) = arctan $(x/\sqrt{1-x^2})$.

3 POWERFUL INTERFACES

FOR THE TRS-80* AND S-100 BUS

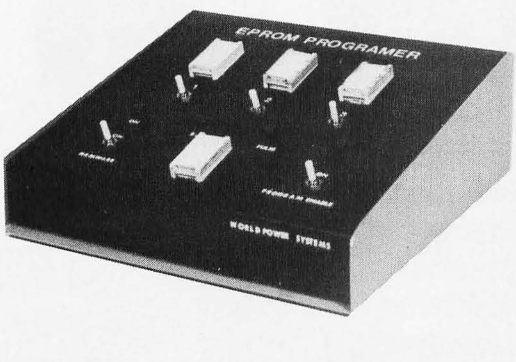


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- **16 OUTPUT LINES:** 8 lines with OPTO-COUPLERS and 8 TTL diode protected.
- **FULL LED PANEL:** For status indicators of all control lines.
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- **EASY CONNECTION:** Plugs into TRS-80 expansion port edge card rear of keyboard or between keyboard and expansion interface.
- **2-EDGE CONNECTORS:** 2-additional expansion 40 pin edge connectors.
- **NEEDS NO SOFTWARE:** Operates from OUT and IN statements from BASIC or machine code statements. Example: (Out 5, 1=turn on switch 5. Out 5, 2=turn off switch 5, etc.)
- **COMPLETE MANUAL AND SAMPLE PROGRAMS:** Comes with comprehensive manual.



Model EPR-80K (kit) $129.95
Model EPR-80A (assem.) $159.95

EPROM PROGRAMMER +3

- **SELF CONTAINED:** Comes housed in an attractive cabinet with self contained power supply.
- **PROGRAMS:** This unit programs the popular 2708, 2716 Eproms. Personality modules for other Eproms will be available at a later date.
- **FIRMWARE:** On board firmware so that no software need be written or entered into your CPU system. The firmware can be shut off when not in use. Firmware residents at F0000. The firmware in and out of system is controlled from a switch on front panel.
- **3-ADDRESSABLE ROM LOCATIONS:** The Eprom Programmer has three sockets on front panel which are addressable to any location by dip switch. In addition each ROM location can be shut off or turned on by switches located on the front panel.
- **MONITOR:** A monitor is supplied within the firmware for performing several functions. Move memory, debug, verify, program from memory, program from TTY input, etc.
- **EASY CONNECTION:** The Eprom Programmer is attached with ease. For the TRS-80 users, the unit plugs into the rear of the keyboard or between the keyboard and expansion interface. Included with the unit are two additional 40 pin edge connections for interfacing of other interfaces. For the S-100 users, a molded connection cable is supplied and it is inserted into one of the connectors on your mother board. Plug it in and it is ready to use.
- **FULLY BUFFERED:** add address and data lines are fully buffered.
- **OTHER FEATURES:** Other features include status lights for which ROM selected, switch enable for programming, pulse (burn) indicator firmware select-deselect switch, on and off and dip switches for the addressing of each ROM location.



Model MS10-K $129.95
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SERIAL PARALLEL I/O MODULE

THIS POWERFUL INERFACE MODULE ALLOWS THE TRS-80 COMPUTER OWNER TO COMMUNICATE OVER 8 SEPARATE RS-232 OR PARALLEL CHANNELS, ALL SELECTABLE FROM A SIMPLE COMMAN IN LEVEL-II OR DISK BASIC OR MACHINE CODE. NOW YOU CAN INTERFACE PRINTERS, TAPE READERS, OTHER RS-232 OR CURRENT LOOP SERIAL DEVICES OR ANY PARALLEL DEVICE.

- **8-SERIAL INPUT/OUTPUT PORTS:** Fully buffered.
- **8-PARALLEL INPUT/OUTPUT PORTS:** Fully buffered.
- **EASY CONNECTION:** Connects to the expansion port edge card connector between keyboard and expansion interface or direct to rear of the TRS-80 keyboard.
- **DIP SWITCH:** All ports, baud rate, parity, etc all set by dip switches.
- **ON BOARD FIRMWARE:** No software driver routine needed for operation of the module. Simple OUT and IN statements operate the module.
- **RS-232, CURRENT LOOP:** All 8 channels can be selected for RS-232 or current loop.
- **BAUD RATE SELECTION:** All channels dip switch selectable for individual baud rates from 110 to 9600 baud.
- **COMPLETE DOCUMENTATION:** Complete instruction manual. Just plug in and set the switches and you are able to communicate with the outside world. This module also includes 2 additional 40 pin edge connectors for connection of other interfaces.

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WATCH FOR MODULE "50"

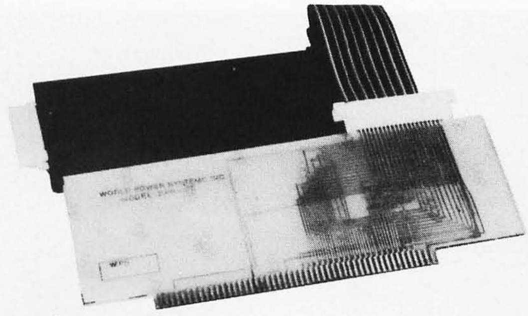
Circle 390 on inquiry card.

3 POWERFUL INTERFACES

FOR THE TRS-80* AND S-100 BUS

TRS-80 TO S-100 BUS CABLE ADAPTER

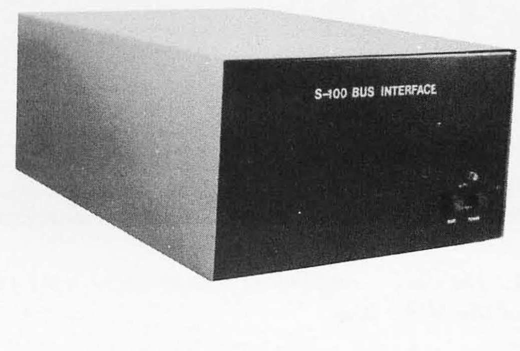
- **FULL INTERFACE:** Contained within the cable assembly, is a small enclosure. This enclosure contains all the logic to convert your TRS-80 to be compatible with the S-100 bus system.
- **FULL BUFFERING:** All address, data and signal lines are fully buffered.
- **EASY CONNECTION:** It is easy to connect. Just plug the one end of the cable into one slot on your S-100 system and plug the other end into the rear of the TRS-80 keyboard or between the expansion interface. Turn on and go . . .
- **TWO EDGE CONNECTORS:** Two addition 40 pin port edge connectors are provided for other connection of expansion interfaces.
- **POWER:** All power is derived from the S-100 bus structure. Since the TRS-80 will not support other devices hooked to its power supply, it is a must that your S-100 supply 8-10 volts D.C. Logic card contained within the cable has on board 5 volt regulator. Current requirements is 375 ma. Unit has separate terminal for exterior connection of DC power requirement if it is to be supplied outside the S-100 bus system.
- **FULL OPERATION MANUAL:** Not much need for a manual, but we have prepared one with full principal of operation, etc.



Model CAB-80K (kit) $99.95
Model CAB-80A (assem.) $119.95

TRS-80 TO S-100 BUS

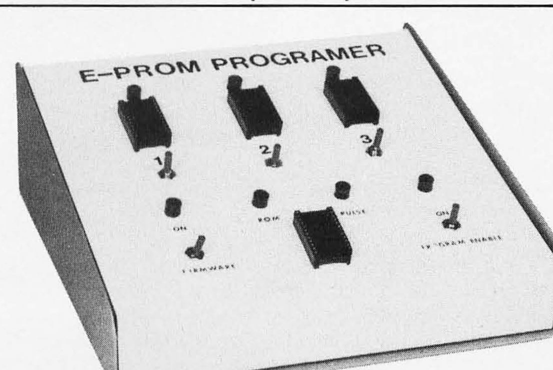
- **FULLY SELF CONTAINED POWER SUPPLY.** (10 AMP)
- **BUS TERMINATION:** Bus termination and conditioning for no cross talk or noise etc.
- **S-100 SIGNALS:** All required S-100 signals are generated by on board logic and is fully compatible with the TRS-80.
- **COMPLETE:** Comes complete with cabinet, card guides, on off switch and sockets. Nothing else to buy.
- **STAND ALONE:** This system can stand alone or can operate with the TRS-80. All input, output, address and signal lines fully buffered between TRS-80 and S-100 BUS system.
- **EASY CONNECTION:** Just plug it into the rear of the keyboard or between the keyboard and expansion interface. Also includes two 40 pin edge connectors for connection to other interfaces.



Model RSB-K (kit) $249.95
Model RSB-A (assem.) $289.95

S-100 EPROM PROGRAMMER +3

*All the same features of the TRS-80 model. Comes complete with interface cable, S-100 plug-in card. Totally self-contained power supply, plus many other extras.



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Model EPR-100A (assem.) $159.95

TERMS
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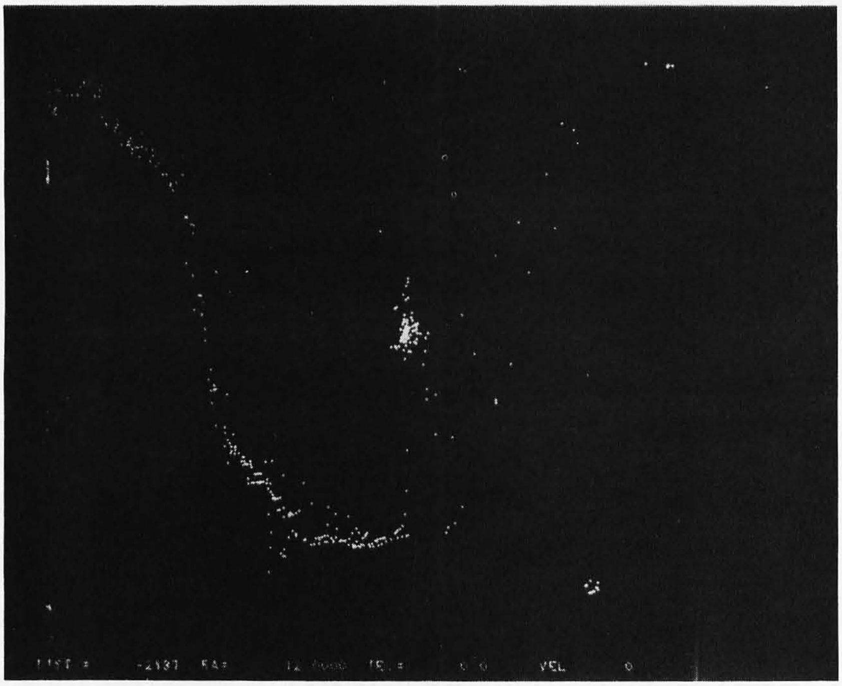


Photo 4: The local constellations from 2937 light years against the background of the Milky Way.

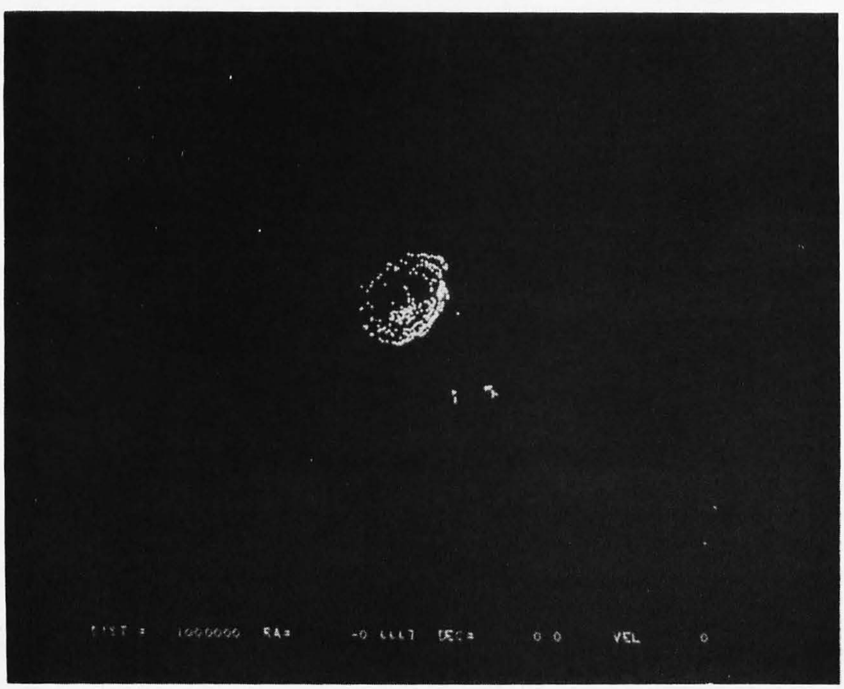


Photo 5: Another side view of the Milky Way galaxy from 1 million light years. The two small objects just below and to the right of the galaxy are the large and small Magellanic Clouds.

Text continued from page 74.

Other Possibilities

Computer enthusiasts who are also interested in astronomy or physics might want to experiment with the Doppler shift effect mentioned earlier—requiring a color graphics display. Also, giving the stars colors related to their surface temperatures might be interesting. Another possibility would be the addition of magnitude (brightness). The IBM-1130 version calculated magnitudes and used different printer characters to indicate stars, but the 2250 does not have a programmable intensity control.

Another interesting possibility lies in the three-dimensional nature of the model. If two images were plotted side by side on the screen at slightly different viewing angles, a pair of stereoscopic viewing glasses would permit a truly three-dimensional view. I have experimented with the stereo three-dimensional effect by placing similar Gould hard copy plots side by side. The sense of depth produced gives one a feeling of vertigo.

Since the model is animated, navigation experiments are possible. Perhaps the algorithms presented here could be written into a game program producing the ultimate celestial exploration game.■

GLOSSARY

Buffer: Temporary storage area in main memory, usually used to prepare or receive data from input or to output devices.

Declination: The angle from the celestial equator to the star. Equivalent to latitude (−90 to 90 degrees).

Doppler shift: Apparent changes in frequency due to direction of travel and speed. For example, if you are moving towards an object that is emitting light, the frequency of the observed light is higher. The reverse is true for the opposite direction of travel.

Extragalactic objects: Objects outside the domain of a galaxy.

Light year: The distance light will travel in one year at 186,284 miles per second (300,000 kilometers per second) – about 5,870,000,000,000 miles.

Magnitude: The brightness of a star. Each unit of magnitude signifies a difference in brightness factor of 2.512.

Right ascension: The arc measured along the equator, from 0 hours to the base of the star's vertical declination circle.

Aw, cut it out!

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New CP/M implementations:
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Software with Manual / Manual Alone

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The Three-Dimensional Celestial

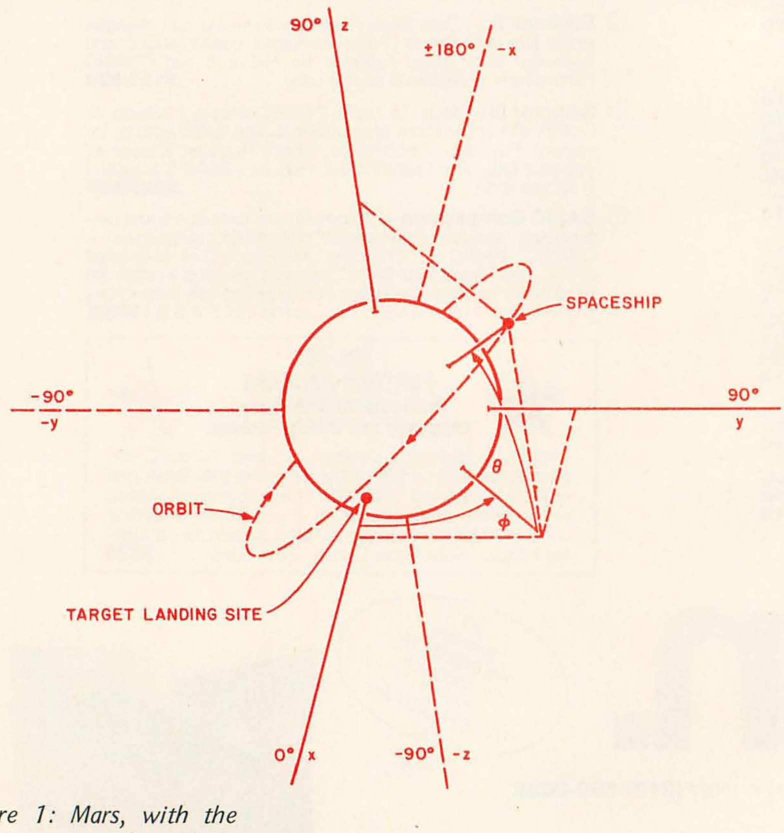


Figure 1: Mars, with the orbiting spaceship and the target landing site. Both rectangular and spherical coordinate systems are shown.

Introduction

The motion of a freely falling body in a gravity field has many interesting characteristics. One of the better methods of showing this is with a simulation, in this case written for the Hewlett-Packard HP-67 or HP-97 programmable calculator.

Lunar lander simulation programs, in which the application of thrust is used to counteract gravity, have become quite popular. Extending the lunar lander concept to two dimensions allows study of the motion of bodies in orbit. Further extension to three dimensions, as in this program, makes it possible to investigate orbital plane changes. Since Mars has a much stronger gravity field than the moon, the effect of gravity is accentuated.

Running the Program

This program is designed as a three-dimensional Mars lander so you can exercise your three-dimensional visualization of space. With a limited fuel supply you can pilot a spaceship from its initial orbit around a spherical simulation of Mars to a soft landing at a designated target site on Mars' surface. The initial orbit does *not* pass over the target site. The three-dimensional trajectory of the spaceship is calculated as a series of segments under your control.

Realistic features of the program include:

- True inverse square law gravity acts upon the estimated midpoint of each trajectory segment.
- The thrust of the spaceship's rocket engine simulates the use of a hydrogen-oxygen fuel, with an exhaust velocity of 4 km/s.
- The spaceship loses mass as fuel is used; with less total mass, the spaceship accelerates more rapidly for the same fuel usage rate.
- If the limited fuel supply is exhausted, the spaceship automatically free-falls to impact on the surface of Mars.
- After impact with or landing on Mars' surface, the actual landing position, velocity, and remaining fuel are interpolated from the segment-end conditions immediately before and after impact. Also, the distance along the spherical surface of Mars from the impact site to the target site is calculated.

To avoid some pilot errors, there are data entry checks: the maximum fuel usage rate is limited to 100 kg/s. The maximum segment duration is limited to 60 seconds. If an attempt is made to burn more fuel than actually remains, only the actual remaining fuel is burned.

Mechanics Simulation for the HP 67/97

One difficult part of landing the spaceship with this program is to correctly interpret exactly where the spaceship is and where it is going at all times; that is, to visualize its movement in three dimensions. To make this as easy as possible, the position is displayed as the spaceship's altitude from Mars' spherical surface, plus two position angles, ϕ and θ, as shown in figure 1. The coordinate system is fixed with the origin at the center of Mars, and both position angles equal 0 at the designated target landing site. If Mars is considered as a globe like the Earth, then angle ϕ is degrees of longitude and angle θ is degrees of latitude. The X,Y plane intersects Mars' surface along its equator. Therefore, angle ϕ is *in* the X,Y plane, and angle θ is *from* the X,Y plane. Then Z and −Z are the north and south poles, respectively. The maximum range of angle ϕ is $\pm(0^\circ$ to $180^\circ)$, while the maximum range of angle θ is $\pm(0^\circ$ to $90^\circ)$. Note that when angle θ is exactly $\pm 90^\circ$, angle ϕ is indeterminate.

Similarly, the spaceship's velocity is displayed as a magnitude and two velocity angles, ϕ and θ. The velocity vector is parallel to the vector from the origin to a position with the same angles. Thus if velocity angles ϕ and θ are both 0, the spaceship's velocity is parallel to the X axis, and toward more positive X values, regardless of the spaceship's position.

Now that we know where we are and where we're going, let us check out the spaceship's operation, summarized in table 1. We must first decide on the initialization method we want to use. To start with a relatively easy landing problem, use the fixed initialization on the Three-Dimensional Mars Lander program card (program listing 1); this always puts the spaceship in the same position and at the same velocity in a nearly circular orbit. When landing from this fixed initialization becomes too easy, use one of the random initialization routines of program listing 2; these put the spaceship at a random altitude (107 to 3,607 km), in a

Step	Instructions	Input	Keys	Output
1	Prepare for Three-Dimensional Mars landing—Use either:			
	(a) Fixed initialization:			
	(1) Load Three-Dimensional Mars Lander program;			0.000
	(2) Initialize;		E	Status
	(3) Go to step 2.			
	(b) Random initialization:			
	(1) Load Random Initialization Program;			0.000
	(2) Optionally, enter a random seed;	.xxxxxx	B	0.xxx
	(3) Optionally, spin for a random seed,		A	—
	wait for a few seconds, then stop;		R/S	1.000
	(4) Initialize for a random circular orbit,		C	Status
	or for a random elliptical orbit;		E	Status
	(5) Load Three-Dimensional Mars Lander			—
2	Optionally, reset segment duration, t seconds.	t	C	t/2
3	Enter either a free-fall or a rocket burn:			
	(a) Free-fall n segments of t seconds each;	n	A	Status
	(b) Rocket burn for one segment of t seconds;			
	(1) Angle of thrust ϕ, degrees;	ϕ	ENTER	
	(2) Angle of thrust θ, degrees;	θ	ENTER	
	(3) Fuel usage rate, kg/s; (0 thru 100)	kg/s	B	Status
4	To calculate next trajectory segment, go to Step 2.			

Notes

- When fuel is gone, there is a print/pause of 10000, then the spaceship free-falls to impact.
- After Mars impact, there is a print/pause of 3393, then the landing status is displayed.
- Status is a double stack review of:

	Stack Register
(a) Segment time, seconds (after landing, impact-to-target distance, km);	T
(b) Position angle ϕ, degrees;	Z
(c) Position angle θ, degrees;	Y
(d) Ship's altitude, km (after landing, vertical error of estimated position);	X
(e) Remaining fuel supply, kg;	T
(f) Velocity angle ϕ, degrees;	Z
(g) Velocity angle θ, degrees;	Y
(h) Ship's velocity, km/s.	X

- Any status display may be repeated by pressing D.

Table 1: Operating instructions for the optional random initialization program and for the Three-Dimensional Mars Lander program.

random three-dimensional direction from Mars, and going in a random direction. The circular initialization puts the horizontal spaceship in a circular orbit. The elliptical initialization puts the spaceship at a random location on an orbit of random ellipticity. Some of these elliptical orbits may eventually terminate on Mars if not modified.

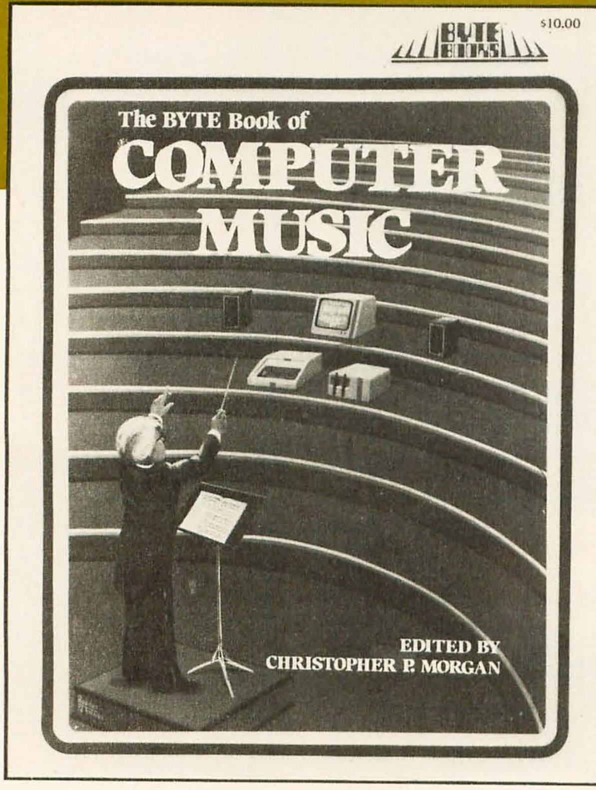
To repeat the same initial conditions with the random orbits, enter the same random seed prior to initialization. For an unpredictable initial status, use the SPIN routine, which increments the random seed until it is manually stopped. Repeated pressing of the C or E keys gives a different initial status each time.

After initialization, the user may change the segment duration (segment time stays as set until reset), then decide whether to free-fall or to make a rocket burn for each segment. Any number of segments of free-fall may be calculated automatically, without intermediate status displays. It is best not to free-fall too many segments at a time initially. Rocket burns are made one segment at a time by specifying the three-dimensional thrust angles and the fuel usage rate for each segment. At a fuel usage rate of 100 kg/s, the initial acceleration rate is about 0.45 gs, gradually increasing to about 4 gs as fuel is used up (gs are units of acceleration: at the Earth's surface, the acceleration of gravity is 1 g, or 9.81 m/s^2). Of course, lower fuel usage rates will give lower acceleration rates. To reverse the direction of a vector in three dimensions (to reduce velocity), add $\pm 180^\circ$ to velocity angle ϕ *and* change the sign of velocity angle θ to get the required thrust angles. (See figure 1 to help visualize this.) Segment duration, thrust angles, and fuel usage rate may be decimal numbers; the number of segments of free-fall must be an integer.

With the fixed initialization, the spaceship starts at position angles of $\phi = 45^\circ$ and $\theta = 35.264^\circ$ (see figure 1). If the spaceship were over the Earth instead of over Mars, this would correspond to a position about 175 km north of Baghdad, in Iraq. The designated landing site is at position angles of $\phi = 0^\circ$ and $\theta = 0^\circ$, or (on the Earth) on the equator and on the Greenwich meridian, due south of Ghana off the Atlantic coast of Africa. Initially, the orbit of the spaceship is horizontal and it is heading due west. If it were over the Earth, the orbit would not cross the equator until just off the east coast of South

Text continued on page 100.

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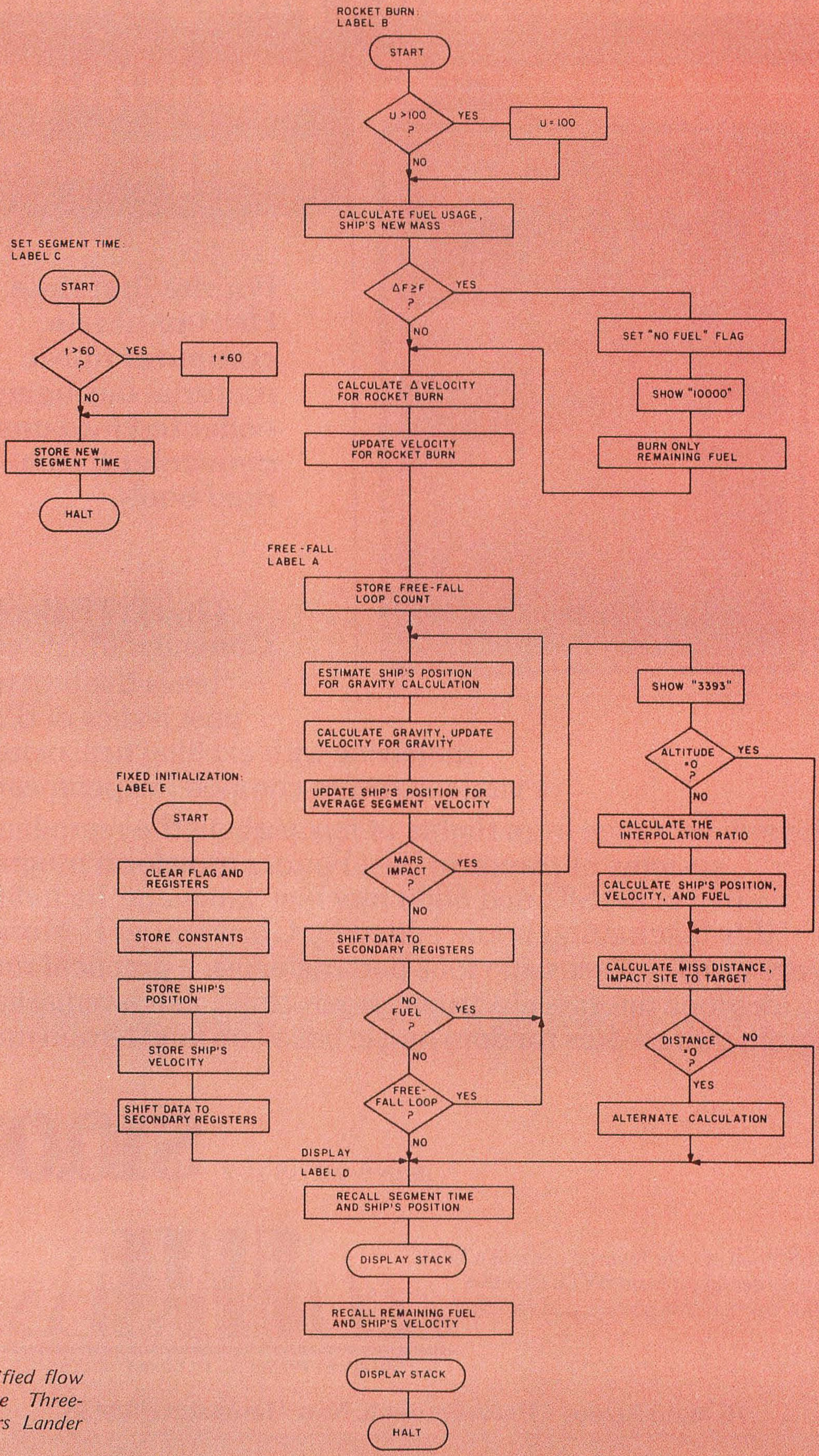


Figure 2: Simplified flow diagram for the Three-Dimensional Mars Lander program.

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Listing 1: Mars Lander program for the HP 67/97 programmable calculator. Clear flags, set for DEG, and set display to FIX 3 before recording program. User entry points are capitalized in comments.

Location	Program Steps						Commentary
001	LBL B	EEX	2	X<Y?	X⇄Y	R↓	ROCKET BURN: Check fuel usage rate,
007	RCL A	X	RCL 7	−			calculate mass loss.
011	CHS	RCL 9	X≠Y	X>Y?			Fuel gone?
015	GSB 9	R↓	STO 7				Update ship's mass and velocity for burn.
018	LST X	÷	LN	4			
022	GSB a	1					
024	LBL A	ST 1					FREE-FALL: Store number of segments.
026	LBL 0	GSB d	CF 0				Free-fall loop: Calculate position for
029	GSB b	x^2	RCL A	X⇄Y			gravity update, update velocity for
033	÷	RCL D	GSB a	P⇄S			gravity, update ship's position.
037	RCL 4	+	R↑	RCL 6			
041	+	R↑	RCL 5	+	R↑		
046	P⇄S	SF 0	GSB b				
049	RCL E	X≠Y?	X>Y?	GTO 7			Impact?
053	−	STO 8	GSB 4				Shift data.
056	F? 1	GTO 0	RCL 0				No fuel?
059	X⇄I	DSZ?	GTO 0				More free-fall segments?
062	LBL D	GSB 2	RCL E				DISPLAY: Current segment time, position,
065	−	RCL A	R↓	STK			fuel, and velocity status.
069	RCL 7	RCL 9	−				
072	GSB d	GSB c	STK	RTN			
076	LBL a	X	P→R	R↑	X⇄Y		Subroutine; Spherical to rectangular, then
081	P→R	STO − 4	R↓	STO − 5			update velocity.
085	R↓	STO − 6					
087	LBL d	RCL 6	RCL 5				Subroutine; Recall velocity.
090	RCL 4	RTN					
092	LBL b	RCL B	X				Subroutine; Calculate new position, then
095	RCL 1	+	F? 0				store new position only if
098	STO 1	R↑	RCL B	X			flag 0 is set.
102	RCL 3	+	F? 0				
105	STO 3	R↑	RCL B	X			
109	RCL 2	+	F? 0				
112	STO 2	R↑					
114	LBL c	R→P	R↓	X⇄Y	R↑	RTN	Subroutine; Rectangular to spherical.
120	R→P	LBL 4	7	X⇄I	STO 0		Subroutine; Shift final segment data into

Listing 1 continued on next page.

Listing 1, continued:

125	LBL 8	RCL (i)	P⇄S	STO (i)			secondary registers.
129	P⇄S	DSZ?	GTO 8	RTN			
133	LBL 2	RCL 3	RCL 2				Subroutine; Recall position.
136	RCL 1	GTO c					(i)
138	LBL 7	− X −	−	X=0?			Impact; Exactly on surface?
142	GTO 6	STO − 8					Calculate interpolation ratio,
144	STO ÷ 8	7	ST I				then interpolate position,
147	LBL 5	P⇄S	RCL (i)	P⇄S			velocity, and fuel
151	RCL (i)	−	RCL 8	÷			data for instant of impact.
155	STO−(i)	DSZ?	GTO 5				
158	LBL 6	GSB 2	R↓	COS			Calculate miss distance;
162	X⇄Y	COS	X	COS⁻¹			
166	5	9	•	2	2	X	
172	X≠0?	GTO 3	RCL 2				if zero, alternate calculation:
175	RCL 3	R→P	LBL 3				
178	STO A	GTO D					Display impact status.
180	LBL 9	SF 1	X	X⇄Y	RTN		Subroutine; Out of fuel.
185	LBL E	CF 1	CL REG				INITIALIZE: Store constants, the fixed
188	3	3	9	3	STO E		
193	4	3	EEX	3			
197	STO D	EEX	4	STO 9			initial position and velocity,
201	9	X	STO 7	GSB c			
205	÷	STO 1	STO 2				
208	STO 3	2	STO 4				
211	CHS	STO 5	GSB 4				
214	GTO D						then display the initial status.
215	LBL C	6	0	X>Y?	X⇄Y		SEGMENT TIME: Check and store.
220	STO A	2	÷	STO B	RTN		

Listing 2: Optional random initialization for Mars Lander. Clear flags, set for DEG, and set display to FIX 3 before recording program. User entry points are capitalized in comments.

Location	Program Steps						Commentary
001	LBL C	SF 2					CIRCULAR: Set for random circular orbit.
003	LBL E	6	0	STO A	2		ELLIPTICAL: Set segment time, gravity
008	÷	STO B	4	3	EEX	3	constant, Mars radius,
014	STO D	3	3	9	3		ship's mass, ship's random radius
019	STO E	9	EEX	4			ϕ and θ.

Listing 2 continued on page 98.

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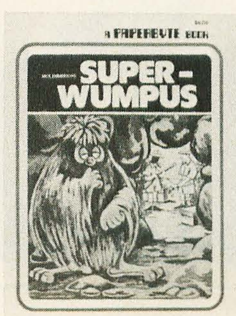
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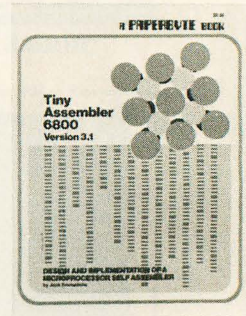
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Author: Jack Emmerichs
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TINY ASSEMBLER 6800, Version 3.1 is an enhancement of Jack Emmerichs' successful Tiny Assembler. The original version (3.0) was described first in the April and May 1977 issues of BYTE magazine, and later in the **PAPERBYTE™** book **TINY ASSEMBLER 6800 Version 3.0.**



In September 1977, BYTE magazine published an article entitled, "Expanding The Tiny Assembler". This provided a detailed description of the enhancements incorporated into Version 3.1, such as the addition of a "begin" statement, a "virtual symbol table", and a larger subset of the Motorola 6800 assembly language.

All the above articles, plus an updated version of the user's guide, the source, object and PAPERBYTE™ bar code formats of both Version 3.0 and 3.1 make this book the most complete documentation possible for Jack Emmerichs' Tiny Assembler.

ISBN 0-931718-08-2
Author: Jack Emmerichs
Pages: 80
Price: **$9.00**

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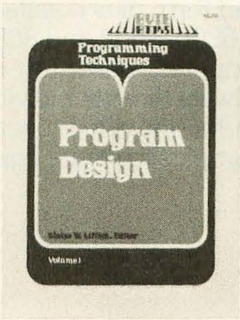
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ISBN 0-931718-12-0
Editor: Blaise W. Liffick
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ISBN 0-931718-13-9
Editor: Blaise W. Liffick
Pages: approx. 80
Price: **$6.00**
Publication: Winter 1979

RA6800ML: AN M6800 RELOCATABLE MACRO ASSEMBLER is a two pass assembler for the Motorola 6800 microprocessor. It is designed to run on a minimum system of 16 K bytes of memory, a system console (such as a Teletype terminal), a system monitor (such as Motorola MIKBUG read only memory program or the ICOM Floppy Disk Operating System), and some form of mass file storage (dual cassette recorders or a floppy disk).

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There is a complete description of the 6800 Assembly language and its components, including outlines of the instruction and address formats, pseudo instructions and macro facilities. Each major routine of the Assembler is described in detail, complete with flow charts and a cross reference showing all calling and called-by routines, pointers, flags, and temporary variables.

In addition, details on interfacing and using the Assembler, error messages generated by the Assembler, the Assembler and sample IO driver source code listings, and **PAPERBYTE™** bar code representation of the Assembler's relocatable object file are all included.

This book provides the necessary background for coding programs in the 6800 assembly language, and for understanding the innermost operations of the Assembler.

ISBN 0-931718-10-4
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Pages: 184
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LINK68: AN M6800 LINKING LOADER is a one pass linking loader which allows separately translated relocatable object modules to be loaded and linked together to form a single executable load module, and to relocate modules in memory. It produces a load map and a load module in Motorola MIKBUG loader format. The Linking Loader requires 2 K bytes of memory, a system console (such as a Teletype terminal), a system monitor (for instance, Motorola MIKBUG read only memory program or the ICOM Floppy Disk Operating System), and some form of mass file storage (dual cassette recorders or a floppy disk).

It was the express purpose of the authors of this book to provide everything necessary for the user to easily learn about the system. In addition to the source code and **PAPERBYTE™** bar code listings, there is a detailed description of the major routines of the Linking Loader, including flow charts. While implementing the system, the user has an opportunity to learn about the nature of linking loader design as well as simply acquiring a useful software tool.

ISBN 0-931718-09-0
Authors: Robert D. Grappel
& Jack E. Hemenway
Pages: 72
Price: **$8.00**
Winter 1979

TRACER: A 6800 DEBUGGING PROGRAM is for the programmer looking for good debugging software. TRACER features single step execution using dynamic break points, register examination and modification, and memory examination and modification. This book includes a reprint of "Jack and the Machine Debug" (from the December 1977 issue of BYTE magazine), **TRACER** program notes, complete assembly and source listing in 6800 assembly language, object program listing, and machine readable **PAPERBYTE™** bar codes of the object code.

ISBN 0-931718-02-3
Authors: Robert D. Grappel
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Pages: 24
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MONDEB: AN ADVANCED M6800 MONITOR-DEBUGGER has all the general features of Motorola's MIKBUG monitor as well as numerous other capabilities. Ease of use was a prime design consideration. The other goal was to achieve minimum memory requirements while retaining maximum versatility. The result is an extremely versatile program. The size of the entire MONDEB is less than 3 K.

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ISBN 0-931718-06-6
Author: Don Peters
Pages: 88
Price: **$5.00**

BAR CODE LOADER. The purpose of this pamphlet is to present the decoding algorithm which was designed by Ken Budnick of Micro-Scan Associates at the request of BYTE Publications, Inc., for the **PAPERBYTE™** bar code representation of executable code. The text of this pamphlet was written by Ken, and contains the general algorithm description in flow chart form plus detailed assemblies of program code for 6800, 6502 and 8080 processors. Individuals with computers based on these processors can use the software directly. Individuals with other processors can use the provided functional specifications and detail examples to create equivalent programs.

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Pages: 32
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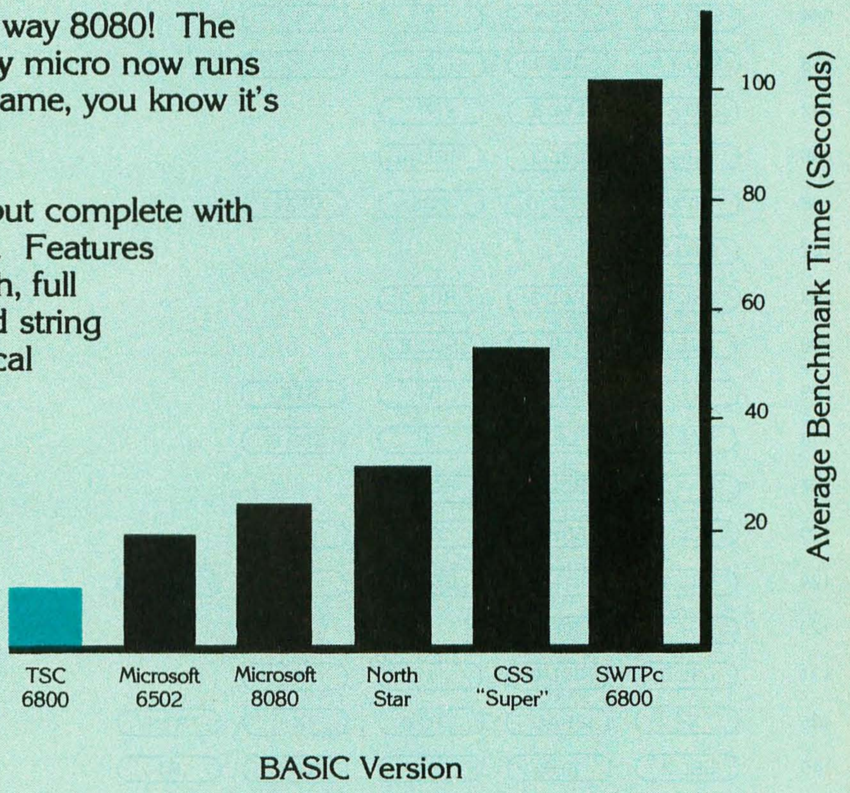
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Listing 2, continued from page 92:

023	STO 7	3	•	5	EEX	3	
029	STO 8	GSB 0	STO + 8	GSB 1			Convert position to X, Y, Z, and store.
033	3.	6	0	X	GSB 1		
038	1	8	0	X			
042	RCL 8	P→R	R↓	X⇄Y	R↑		
047	P→R	STO 1	R↓	STO 2			
051	R↓	STO 3					
053	RCL D	RCL 8	÷	√X			Calculate circular orbit velocity,
057	STO 9	GSB 1	STO 4				random X, Y, Z velocity for an orbit
060	RCL 1	X	GSB 1				horizontal at the ship's
063	STO 5	RCL 2	X	+			
067	CHS	RCL 3	÷	STO 6			position,
071	RCL 5	RCL 4	GSB 2				
074	RCL 9	÷	STO ÷ 4				adjust X, Y, Z velocity.
077	STO ÷ 5	STO ÷ 6	F? 2				Circular orbit?
080	GTO 5	GSB 1	2	÷			If elliptical orbit,
084	STO + 4	GSB 1	2	÷			make random
088	STO + 5	GSB 1	2	÷			X, Y, Z velocity adjustment.
092	STO + 6	LBL 5	7				
095	ST I	LBL 3	RCL (i)				Shift data from primary to
098	P⇄S	STO (i)	P⇄S	DSZ?			secondary registers.
102	GTO 3						
103	LBL D	RCL 3	RCL 2				DISPLAY: Show segment time,
106	RCL 1	GSB 2	RCL E				ship's position,
109	−	RCL A	R↓	STK			fuel,
113	RCL 7	EEX	4	STO 9			and velocity.
117	−	RCL 6	RCL 5				
120	RCL 4	GSB 2	STK	RTN			
124	LBL 1	1	GSB 0	•	5		Subroutine; Randomize position and velocity.
129	−	RTN					
131	LBL 0	RCL 0	π	+			Subroutine; Random number generator.
135	X^2	FRAC	STO 0	X	RTN		
140	LBL 2	R→P	R↓	X⇄Y	R↑		Subroutine; Rectangular to spherical.
145	R→P	RTN					
147	LBL A	CL REG	1	CHS			SPIN: A random seed randomizer.
151	ST I	CHS	STO + 0				
154	GTO (i)						
155	LBL B	STO 0	RTN				SEED: To store user's random seed.



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Operation	Keys	Display	Explanation
Load Three-Dimensional Mars Lander program	–	0.000	–
Initialize (fixed orbit)	E	60.000	T Default segment time, seconds
		45.000	Z Position angle ϕ, degrees
		35.264	Y Position angle θ, degrees
		1803.152	X Ship's altitude, km
		80000.000	T Initial fuel supply, kg
		–45.000	Z Velocity angle ϕ, degrees
		0.000	Y Velocity angle θ, degrees
		2.828	X Ship's velocity, km/s
Rocket burn for 60 seconds, $\phi = 135^\circ$, $\theta = 0^\circ$, 100 kg/s	135, ENTER, 0, ENTER, 100, B	60.000	T Segment time, seconds
		42.820	Z Position angle ϕ, degrees
		35.245	Y Position angle θ, degrees
		1802.794	X Ship's altitude, km
		74000.000	T Remaining fuel supply, kg
		–46.751	Z Velocity angle ϕ, degrees
		–1.238	Y Velocity angle θ, degrees
		2.553	X Ship's velocity, km/s
Free-fall 66, 60 second segments	66, A	60.000	T Segment time, seconds
		–115.974	Z Position angle ϕ, degrees
		–33.762	Y Position angle θ, degrees
		5.694	X Ship's altitude, km
		74000.000	T Remaining fuel supply, kg
		145.618	Z Velocity angle ϕ, degrees
		–7.423	Y Velocity angle θ, degrees
		3.907	X Ship's velocity, km/s
Free-fall one, 35 second segment	35, C, 1, A	3393.000	Impact signal
		6706.884	T Impact-to-target distance, km
		–118.488	Z Impact position angle ϕ, degrees
		–34.135	Y Impact position angle θ, degrees
		–0.206	X Impact position vertical error, km
		74000.000	T Remaining fuel supply, kg
		144.164	Z Impact velocity angle ϕ, degrees
		–6.425	Y Impact velocity angle θ, degrees
		3.913	X Ship's impact velocity, km/s

Table 2: Demonstration of the Three-Dimensional Mars Lander program's operation. Note that the thrust from the rocket burn is directly opposite to the initial velocity.

Text continued from page 86:

America. Follow the demonstration example in table 2 to help to understand the spaceship control, and the status displays. The HP-97 prints status displays.

A good landing is within 100 m (0.100 km) of the target site, with a near-vertical descent ($\phi = \pm 180^\circ$, and $\theta = 0^\circ$, for velocity angles), and at an impact velocity of less than 1 m/s (0.001 km/s). There is plenty of fuel on board to make a good landing at the target site from even a "worst case" random orbit. The initial mass ratio is 9 to 1.

Note that the display reads in kilometers and in km/s; in the normal FIX 3 display format, you can read down to the nearest meter and m/s. When near to landing, it is helpful to change the display to FIX 6, so that you can read down to the nearest millimeter and mm/s. Also note that during descent, the spaceship's position is given in degrees, and on Mars' surface, one degree is about 60 km.

Celestial Mechanics

Celestial orbits of a relatively light body around a massive primary may be represented by the conic sections: circle, ellipse, parabola, and hyperbola, all formed by the intersection of a plane with a cone at various angles. In this program we are concerned only with circular and elliptical orbits, since parabolas and hyperbolas represent nonrepeating, or one pass orbits.

In a circular orbit, the orbiting body always has the same velocity and the same distance from the primary. The attraction of gravity is exactly balanced by the centrifugal force at all times. Both the body's potential energy (a result of altitude) and its kinetic energy (a result of velocity) are constant.

An elliptical orbit is far more common; a circular orbit is really just a special case of an elliptical orbit. In an elliptical orbit, the body's velocity and its distance from the primary are continually varying. While the body's potential energy varies with its alti-

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tude, and its kinetic energy varies with its velocity, its total energy remains constant. Its energy is merely oscillating between kinetic and potential forms.

If we are in a spaceship, how do we change altitude with a minimum energy usage (ie: minimum fuel usage)? Under some special circumstances, this is fairly straightforward. For example, to go from one circular orbit to another circular orbit in the same plane — but at a different altitude — the minimum-fuel-usage maneuver is known as a *Hohmann transfer.* It is simply an ellipse tangent to both circular orbits. A Hohmann transfer is made in three stages:

(1) Thrust along the current direction of motion (or against it) until the velocity has increased (or decreased) enough to form an elliptical orbit that reaches just up (or down) to the desired new circular orbit altitude;
(2) Wait in elliptical transfer orbit until the new altitude has been reached on the opposite side of the primary from the start;
(3) Thrust along the current direction of motion (or against it) until the orbit has been circularized at the new altitude. Note that the direction of this second thrust must be opposite to the initial direction of thrust (since we are now on the opposite side of the primary), though both increase (or decrease) the spaceship's velocity.

But how can we use this method to land on the surface of the primary? Just perform a Hohmann transfer to *zero* altitude, then stop! Of course, this assumes that the landing trajectory is tangent to the surface, and that we stop instantly. While this is theoretically the most efficient way to land from orbit, we can't quite actually do it this way; we have to leave some room to slow down and stop and a little extra for maneuvering room. However, the closer we can approach this theoretical minimum-fuel-usage landing, the lower the actual fuel usage will be.

To repeat: for a minimum-fuel-usage landing from orbit, an initial rocket burn is made when the spaceship is on the opposite side of the primary from the landing site to slow down enough to pass over the landing site at a low altitude; then free-fall until near to the target site. At the last possible moment, again make a rocket burn (or series of rocket burns) to stop orbital velocity, and to land vertically on the surface at the target site. Note that Mars' very thin atmosphere is ignored.

But what do we do when the landing site is *not* in the plane of the orbit? Just change the plane of the orbit so that the landing site *is* in the plane of the orbit. This can create two complications:

(1) Since orbital velocity around Mars is fairly high, it takes a lot of fuel to change the plane of the orbit;
(2) In general, the heading of the spaceship in orbit is continually changing. But what is the proper heading to make the plane of the orbit pass through the landing site?

The answer to (1) is, literally, roundabout. If the plane change is very great, it will save fuel to first do a Hohmann transfer to a higher altitude so that the spaceship's velocity will be lower, before changing the plane of the orbit. Then come back down on another elliptical orbit to a low altitude over the target landing site. In answer to (2), there are two planes that the spaceship's orbit can be in, that also pass through the target site, where the heading does not change: the equator, and the Greenwich meridian. If we approach the target site along the equator or along the Greenwich meridian, there is no problem of constantly changing headings.

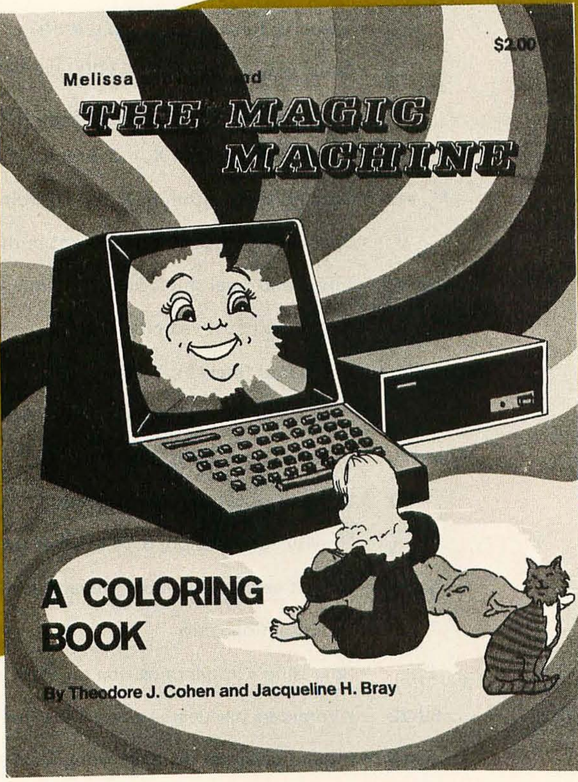
Note that any free-fall orbit is planar (that is, flat), and that the plane of the orbit always passes through the center of the primary. Therefore the orbit's path on the surface of the primary is always a *great circle.* (A great circle is formed by the intersection of the primary's surface with a plane passing through the center of the primary.) It passes over the equator twice for each complete orbit, and over the Greenwich meridian (or its extension, position angle $\phi = \pm 180°$) twice for each complete orbit.

Program Organization

To squeeze this rather complex program into the 224 program steps available in the Hewlett-Packard HP-67/97, considerable use was made of subroutines, as shown in program listing 1. Note that subroutines may have two entry points. To translate this program to other systems, remember that the HP-67/97 uses RPN (reverse Polish notation) on a 4 register stack. Therefore function symbols *follow* data entry, the same as though you were doing the calculation manually. Flags and conditional tests skip the following program step if the test is false.

The more important equations used for calculating the random initialization, the

Text continued on page 108.



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Operation	Variable Definition
Random Initialization:	V_{co} = Velocity for a circular orbit, km/s
$V_{co} = \sqrt{C_g/R}$	C_g = Mars' gravity constant, 43,000 km^3/s^2
$RV_z = -(RV_x P_x + RV_y P_y)/P_z$	R = Radius, Mars' center to spaceship, km
	RV_z, etc = Relative velocity in X,Y,Z directions
Spaceship's Trajectory:	P_x, etc = Spaceship's position in X,Y,Z coordinates
$V_r = V_i - V_{exh} \ln(M_f/M_i)$	V_r = Spaceship's velocity after rocket burn, km/s
$P_g = P_i + V_r t/2$	V_i and V_f = Initial and final ship's velocity, km/s
	V_{exh} = Rocket exhaust velocity, 4 km/s
$g = C_g/R^2$	M_i and M_f = Initial and final ship's mass, kg
$V_f = V_r - gt$	P_g = Position of spaceship for gravity calculation
$P_f = P_i + (V_i + V_f)t/2$	P_i and P_f = Initial and final ship's position
	t = Segment duration time, seconds
After Impact with Mars' Surface:	g = Gravity acceleration, 3.74 m/s^2 at surface
$V_{imp} = V_f + c/d(V_i - V_f)$	V_{imp} = Impact velocity on Mars' surface, km/s
	c/d = Interpolation ratio
$P_{imp} = P_f + c/d(P_i - P_f)$	P_{imp} = Spaceship's impact position on Mars' surface
Distance = $59.22(\cos^{-1}((\cos\phi)(\cos\theta)))$	59.22 = Kilometers per degree along Mars' surface
or:	Distance = Impact-to-target distance along Mars' surface, km
Distance = $\sqrt{P^2_{y(imp)} + P^2_{z(imp)}}$	ϕ and θ = Spaceship's impact position angles, degrees
	$P_{y(imp)}$ = Spaceship's Y impact position, km
	$P_{z(imp)}$ = Spaceship's Z impact position, km

Table 3: Random initialization, spaceship trajectory, and impact status calculations. The trajectory and impact equations do not give exact velocity and impact data, but do give good approximations. The calculated values increase in accuracy as segment duration and velocity decrease and as radius increases. While the equations are shown in their simplest linear form, calculations are actually carried out in three dimensions, using rectangular or spherical coordinates. Note that the initial conditions for one segment were the final conditions for the previous segment.

Polar to Rectangular:

$X = R \cos A$

$Y = R \sin A$

where:

X,Y = Rectangular coordinates

R,A = Radius and angle of polar coordinates

Rectangular to Polar:

$R = \sqrt{X^2 + Y^2}$

$A = \tan^{-1}(Y/X)$

For calculation of the angle A:

a) If X = 0, substitute a very small number for X, ie: perhaps 10^{-10}

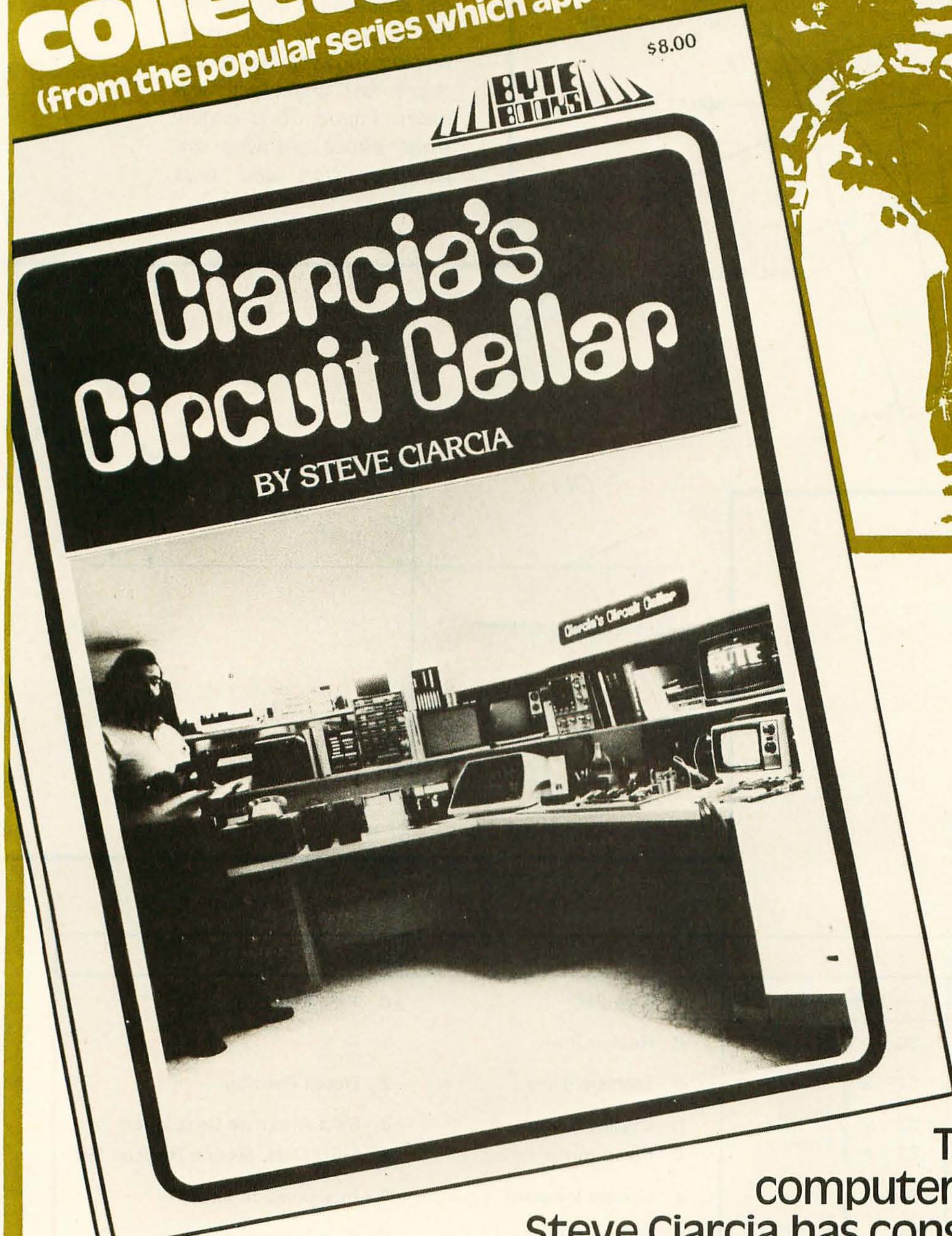
b) If X < 0, add 180° to A

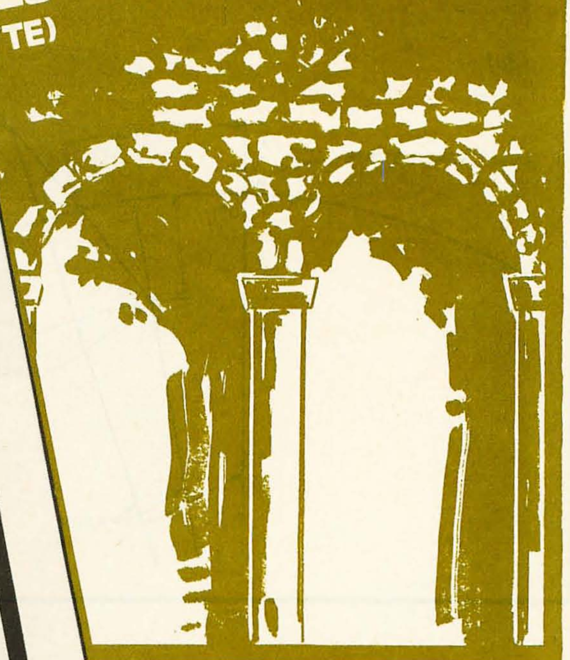
c) If X < 0 *and* Y < 0, subtract 180° from A

Table 4: Polar-to-rectangular and rectangular-to-polar coordinate conversions.

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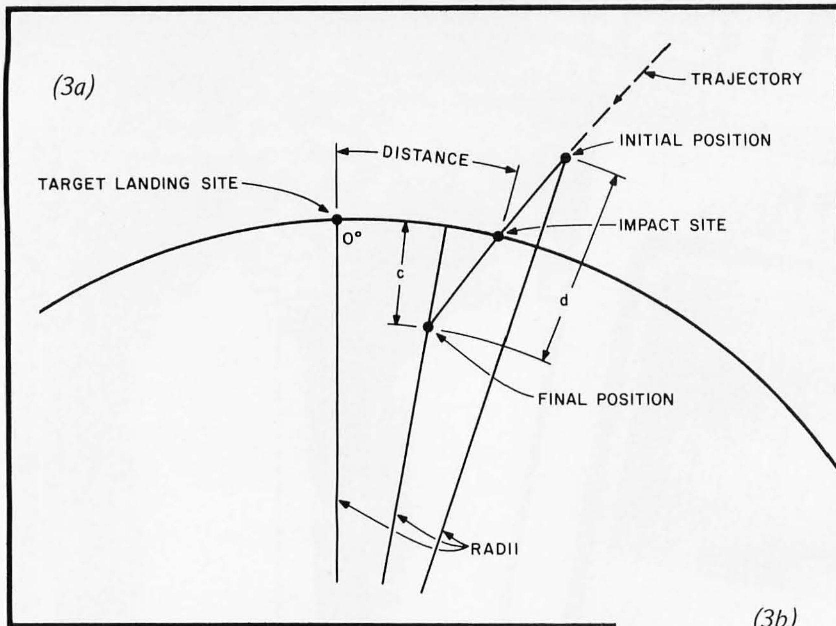


Figure 3: Interpolation of the spaceship's landing status. Figure 3a is a cross-section showing the spaceship's last trajectory segment. Figure 3b is a view from above showing impact position and miss distance.

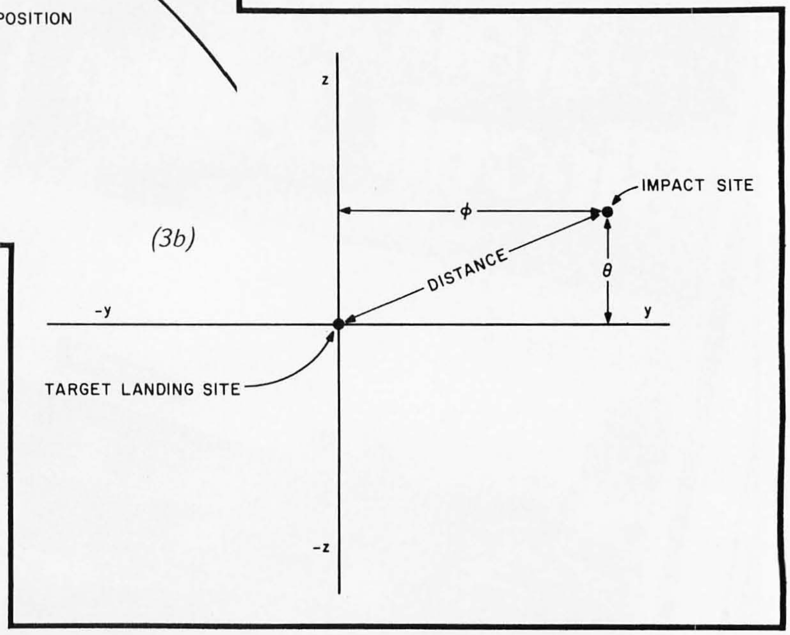


Table 5: Register, label, and flag usage for the Three-Dimensional Mars Lander program.

Registers

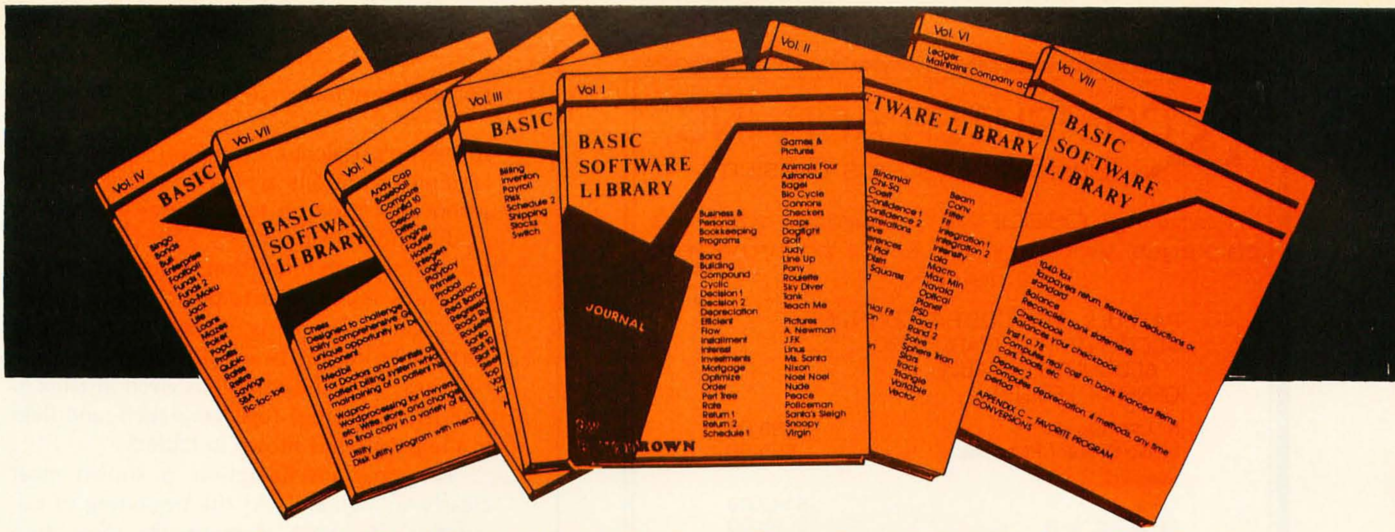
Primary		Secondary	
0	Temporary Loop Count	S0	—
1	x } New Position	S1	x } Initial Position
2	y } New Position	S2	y } Initial Position
3	z } New Position	S3	z } Initial Position
4	x } New Velocity	S4	x } Initial Velocity
5	y } New Velocity	S5	y } Initial Velocity
6	z } New Velocity	S6	z } Initial Velocity
7	Ship's Mass	S7	Ship's Mass
8	Last Altitude	S8	—
9	10,000	S9	—
A	Segment Time, t		
B	t/2		
C	—		
D	Gravity Constant		
E	Mars' Radius		
I	Loop Count		

Labels

A	Free-Fall	0	Free-Fall Loop
B	Rocket Burn	1	—
C	Segment Time	2	Recall Position
D	Display Status	3	Skip Alternate Calculation
E	Fixed Initialization	4	Shift Data, Second Register Set
a	Update Velocity	5	Interpolation Loop
b	Update Position	6	Skip Interpolation
c	Rectangular to Spherical	7	Mars Surface Impact
d	Recall Velocity	8	Data Shift Loop
e	—	9	Out of Fuel

Flags

0	On, Store New Position
1	On, Out of Fuel
2	—
3	—



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- **Readable** – as all of our programs are reproduced full size for ease in reading.
- **Virtually Machine Independent** – these programs are written in a subset of Dartmouth Basic but are not oriented for any one particular system. Just in case your Basic might not use one of our functions we have included an appendix in Volume V which gives conversion algorithms for 19 different Basic's; that's right, just look it up and make the substitution for your particular version. If you would like to convert your favorite program into Fortran or APL or any other language, the appendix in Volume II will define the statements and their parameters as used in our programs.

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Text continued from page 102:

spaceship's trajectory, and for interpolating landing conditions are given in table 3. The second equation on table 3 uses the method of direction cosines to set a horizontal orbit for any spaceship position. Many systems do not have rectangular-to-polar and polar-to-rectangular functions; these may be performed using software functions or subroutines, with the equations given in table 4. The use of storage registers, labels, and flags in the program is shown in table 5.

The program operation is shown most clearly in figure 2. At the beginning of calculations for each segment, the same position, velocity, and fuel data are in both the primary and the secondary registers. During the rocket burn and free-fall calculations, only the data in the primary registers is progressively updated. After all trajectory calculations for the segment have been made, the secondary registers still contain the initial segment data, while the primary registers now contain the final segment data. Then there is a test for Mars impact during the segment; if impact has occurred, initial and final segment data are used to interpolate impact status; if impact has not occurred, primary register data is copied into the secondary registers in preparation for calculation of the next segment. If the program is still in a loop of free-fall segment calculations, the next segment is calculated; otherwise, the current status data is displayed and the program halts.

The impact interpolation method is shown in figure 3. The calculated impact-to-target distance is correct only for the hemisphere of Mars that is centered upon the designated target site. If the landing is within a square about 240 meters on a side centered upon the designated target site, roundoff in the cosine function causes a calculated miss distance of 0. If you are this close, Mars' surface may be considered as flat, and a simpler alternate miss distance calculation is used.

Conclusions

This program may be considered as primarily a game program, or as primarily a celestial mechanics simulation program. In either case, as you learn how to control the spaceship for better landings using less fuel, you will also be learning more about the intuitive "feel" of celestial mechanics, and will gain a greater appreciation of some of the problems of space flight.

Watch that fuel gauge, and happy landings!■

The Standard Data Encryption Algorithm

Part 2: Implementing the Algorithm

Robert V Meushaw
4188 Brittany Dr
Ellicott City MD 21043

Part 1 of this article described the five basic functions which must be performed to implement the Standard Data Encryption Algorithm:

- permutation operations,
- table lookup,
- circular rotation,
- byte exchange, and
- modulo 2 addition.

Of course, there are many iterations of these functions in the encryption and decryption process.

Design Approach

When I began the design, I knew that there were many possible approaches. However, I also knew that the one hard constraint I faced was the amount of memory available on the basic KIM-1 computer. This constraint was the determining factor in the design, and, as a consequence, in the efficiency and speed of the implementation. In order to determine how much memory I would have for the program, I began to estimate the amount of storage I would need to hold all of the tables I needed. My preliminary estimate was that for each entry in each permutation table I would need one byte (I actually needed slightly more, as you will see). This assumption meant that I would need 312 bytes – almost one third of the memory available to me. I next looked at the Select S1 thru S8 function. There are eight separate tables with 64 entries each. However, since each table entry required only four bits instead of eight (the entries range from hexadecimal 0 to F), I knew that if I was clever I could get away with half a byte per entry. I would still need 256 bytes for these tables, of course. So before I even started on the program, one half my available memory was committed.

The impact of the above results became clear when I looked at the memory requirements for subkeys K1 thru K16. Each subkey would require 6 to 8 bytes (depending on how data was represented), giving a possible total storage requirement of 128 bytes. Since I would be left with only about 128 bytes for the program (and I didn't think that was enough) I made the decision to generate each subkey as I needed it.

Module Design Difficulties

The actual design of the individual modules went through several iterations. My primary problem was that the optimization of the overall program meant that the design of each module was intimately involved with the design of other modules—not usually a good design approach. A revision of any module usually resulted in several iterations of changes to other modules. An example of this coupling is the following:

- efficient design of the Select S1 thru S8 module requires inputs to be available as 8 bytes of 6 bits each.
- in order to generate the input as required above, the subkey and the results of the Select E permutation must be represented as 8 bytes of 6 bits each.
- the design of the module which performed the permutation function had to be modified and reoptimized to allow for less than 8 bits per byte in the result.

I am sure that many readers have encountered the same type of difficulty in developing relatively complex software which must be optimized for speed, space, or both. It was a frustrating experience because of the many revisions required.

Data Movement

One of the first tasks in designing this program, or any program, was the definition of the data structures and the data transfers which will occur. The basic data elements to be manipulated are:

- 8 bytes of plaintext input (PT)
- 8 bytes of key (KEY)
- 8 bytes of subkey (SUBKEY)
- 8 bytes for Ci and Di (CD)
- 8 bytes of storage for intermediate results (TEMP).

Text continued on page 114.

1		PT	Initial permutation →	PT
2		Key	Permuted Choice 1 →	CD
3		CD	Permuted Choice 2 →	Subkey
4		PTright	Select E →	Temp
5	Temp ⊕	Subkey	→	Subkey
6		Subkey	Select S1 thru S8 →	Temp
7		Temp	Permute P →	Temp
8	PTleft ⊕	Temp	→	PTleft
9		PT	Inverse initial permutation →	PT

Table 8: Data transformations and movement used in software implementation of the Standard Data Encryption Algorithm. This table does not include the exchange of PTleft and PTright used in block transformation.

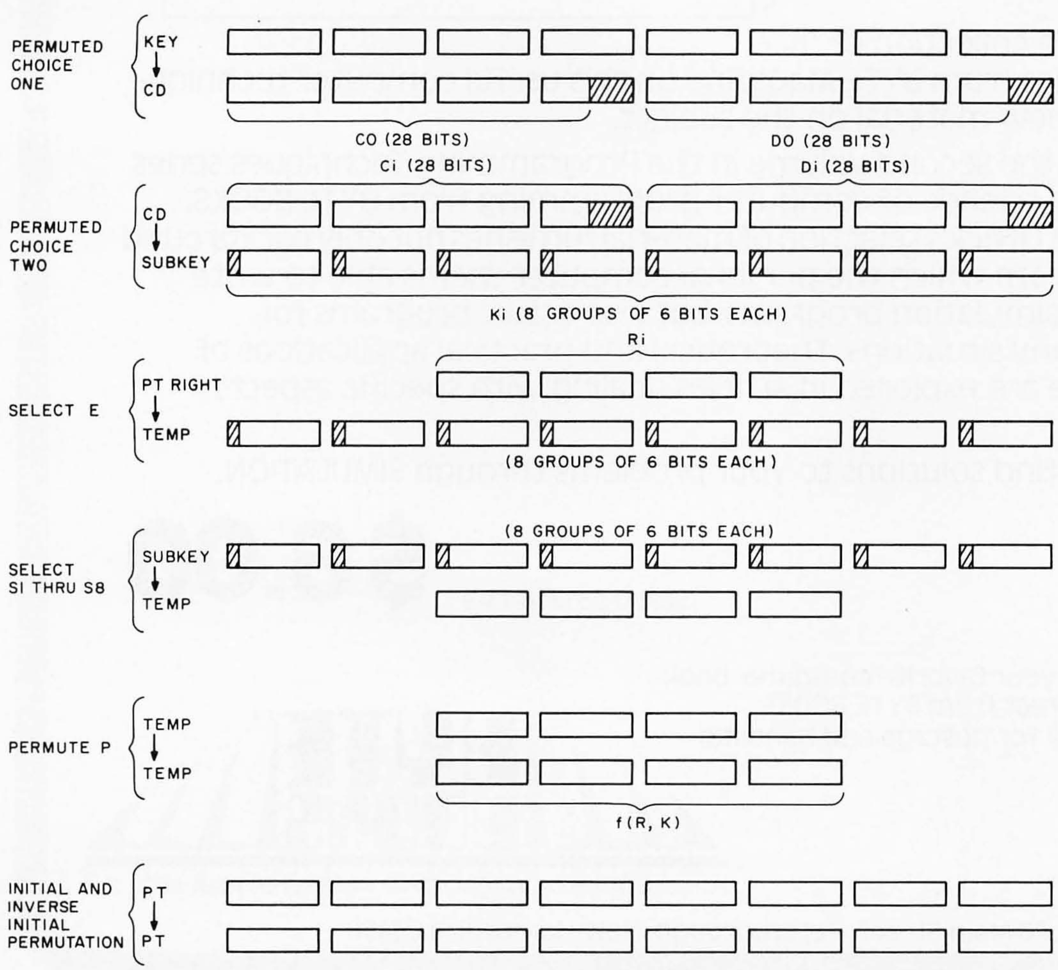


Table 9: Data format and data movement used in the software implementation of the Standard Data Encryption Algorithm.

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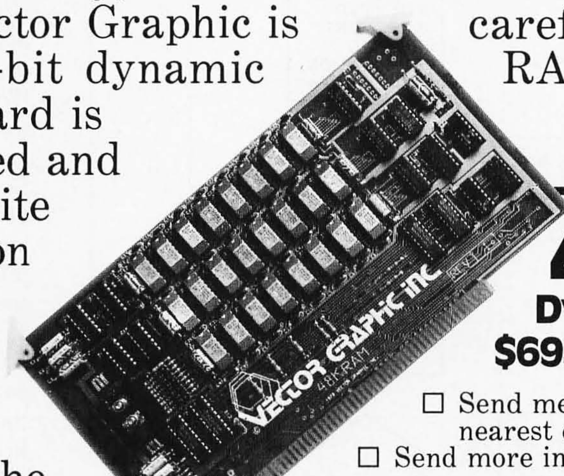
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Text continued from page 111:

Table 8 depicts the data transformations and data transfers that occur. The first item shows that the plaintext data is permuted by the initial permutation and stored in the bytes originally occupied by the plaintext data.

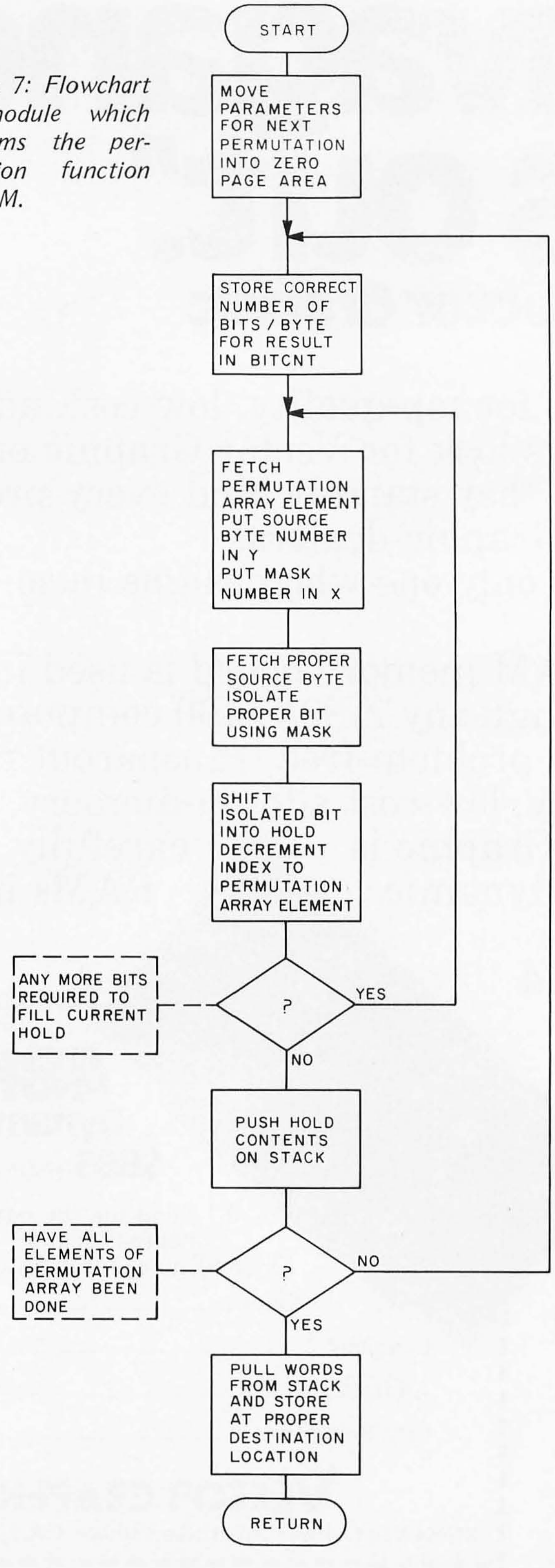


Figure 7: Flowchart of module which performs the permutation function TFORM.

For each of the transformations which occur, table 9 shows the format of both the data input and the results of the operation. Each rectangular box represents one byte. As an example, consider the transformation Permuted Choice 2 (PC-2). The input is Ci (28 bits) and Di (28 bits) and the output is stored as 8 blocks of 6 bits each. The label CD (to the left) shows the *source* data, and subkey shows the *destination* of the results of the permutation.

Permutation Module: TFORM

At this point I can begin the detailed explanation of the major modules. The module where most of the work is done (and where most of the time is spent) is TFORM. Steps 1, 2, 3, 4, 7 and 9 of table 8 depict the permutation functions performed. The operation of this module is similar in each case; only the input parameters are different. The primary input parameters to TFORM are: *source* data address, *destination* address for results, and *permutation table* address. For example, to perform the permutation shown in step 4 of table 8, TFORM would get the source address of PT (right), the destination address of TEMP, and the table address of the Select E permutation.

A general flowchart of TFORM is shown in figure 7. It provides a top level description of the operation for those readers who want to program the function on different machines.

The first task is to update the input parameters used by the routine. In addition to the parameters described above, the routine also needs the number of elements in the permutation table (PCOUNT), the number of bytes in the result of the permutation (WCOUNT), and the number of bits in each result byte (BCOUNT).

Here's how the permutation is done. The first element of the permutation table is obtained. This element tells which bit of the input is the first bit of the result, as follows: referring to figure 8, bits 0, 1 and 2 refer to the byte of the source data to be used; bits 3, 4, 5 and 6 refer to a mask number to be used to isolate the proper bit. At this point, an example might help. Figure 9 shows how the first bit of Permute P is obtained. The first bit of the result is bit 16 of the input — this corresponds to byte 1 of the input

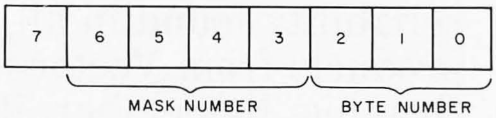
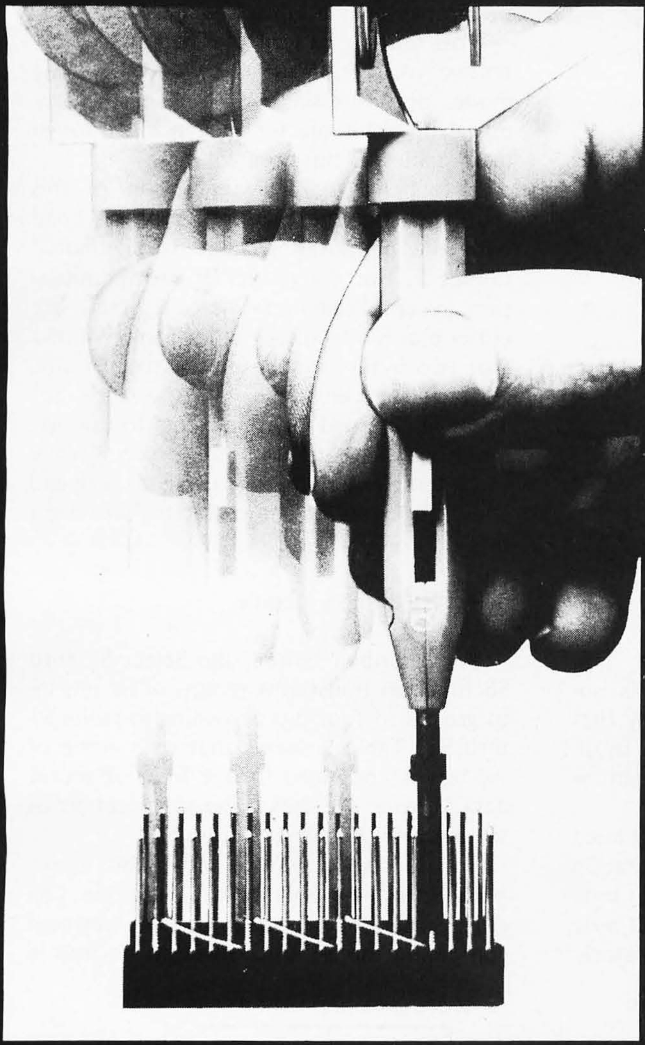


Figure 8: Format of elements of permutation table.

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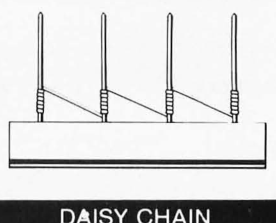
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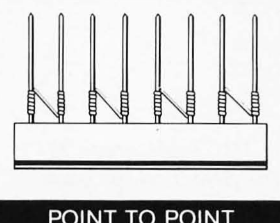
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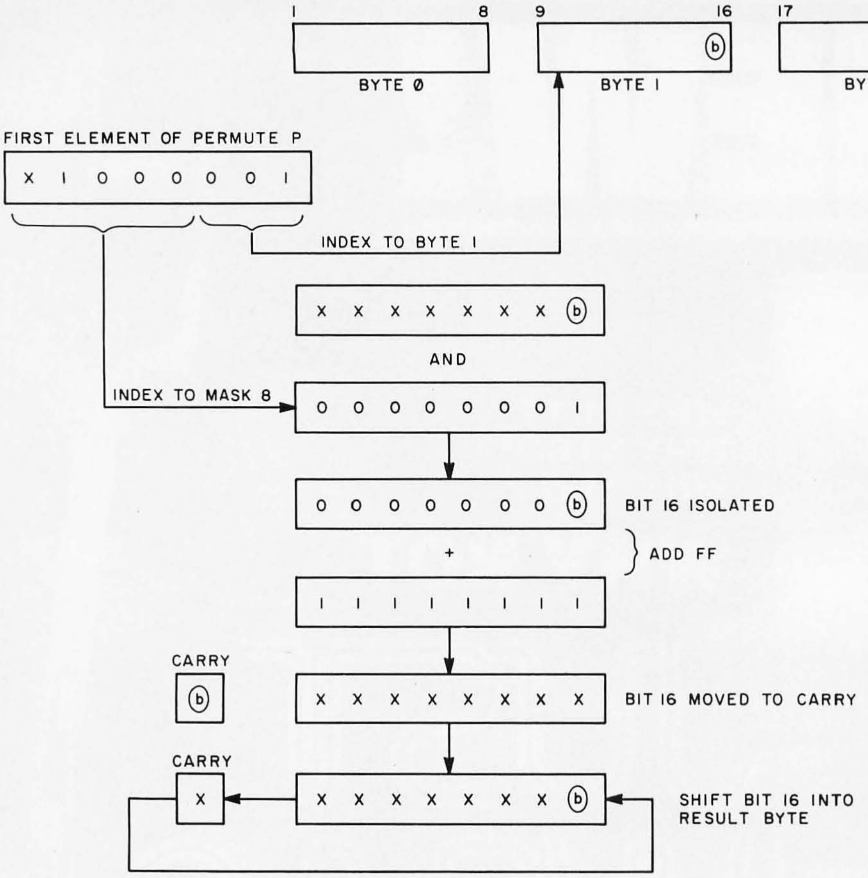


Figure 9: Example of permutation operation being used to obtain first bit of Permute P result.

ANDed with mask 8. Once the bit is isolated, it is forced into the carry bit by first clearing the carry bit and then adding hexadecimal FF. The value of the carry bit is then shifted into the result byte.

The process described above is continued for all the elements of the permutation table. The number of bits in each result byte is controlled by BCOUNT. Each result byte is temporarily stored on the program stack. After completion of all bit permutation operations using all table elements, the result bytes are taken from the stack and placed at the proper destination address.

This routine, as well as others, makes extensive use of the 6502 *indirect, indexed* mode of addressing. It is a particularly powerful technique for sequencing through many tables, as this program does.

Before leaving the description of this routine, I should explain one problem I had with the permutation table for Permuted Choice 1. For the results of each permutation except Permuted Choice 1, there are either 6 or 8 bits in each byte. Table 9 shows that two bytes of the result have only 4 bits. To achieve consistency in the code for TFORM, I added eight elements to the permutation table of Permuted Choice 1. They force these extra bits to 0, using mask 0, and allow all bytes of the result to have eight bits.

Select S1 thru S8 Module

As described before, the Select S1 thru S8 function transforms groups of six bits into groups of four bits according to tables S1 thru S8. Table 9 shows that each group of six bits is contained in one byte of source data. Figure 10 shows the organization of the data for the tables S1 thru S8.

In order to transform each 6 bit source group into the proper 4 bit result group, you must generate an *index* into the segment containing the S1 thru S8 data. As seen in

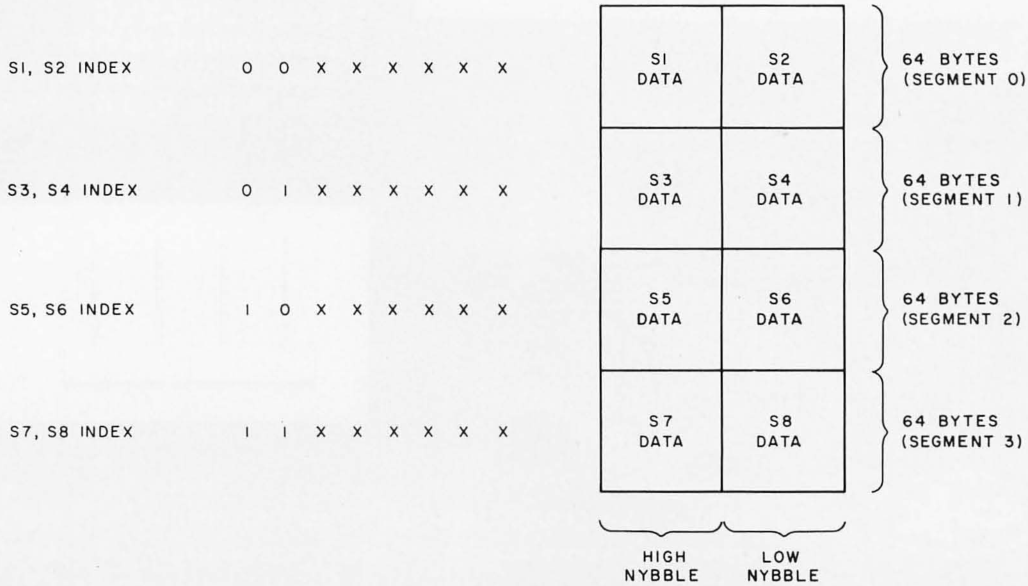


Figure 10: Table organization for Select S1 through S8 data.

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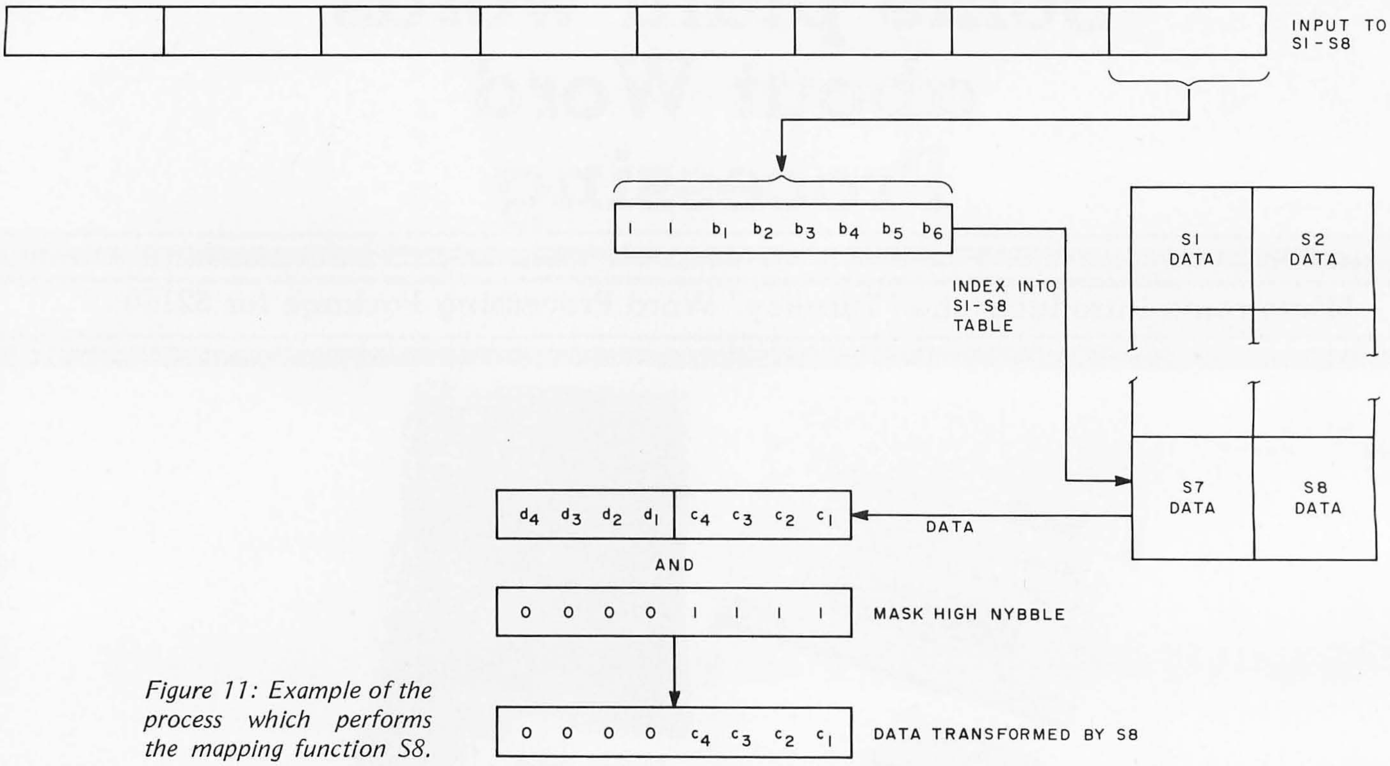


Figure 11: Example of the process which performs the mapping function S8.

figure 10, the index into each individual table is controlled by bits 6 and 7 of the index byte.

Let's examine how to map the last byte of the source data using S8. Figure 11 shows that the low order 6 bits from the source byte are used to select a byte from the 64 bytes in the S7, S8 segment. To access the correct 64 byte segment (S7, S8) we force the two high order bits to 11. The resulting byte is used as an index into the table. If you mask the high 4 bit word of the accessed byte (which also contains S7 data), the proper S8 data is selected. Of course, the table data must be properly ordered within S8, but that's fairly easy.

In order to carry out the other transformations, you proceed in a similar fashion. The only changes would be the two high order bits used to index the proper segment of the table, and whether you mask the low or high nybble.

A general flowchart of this module is provided in figure 12.

ROTATE Module

As I said before, I decided to generate each subkey as I needed it. To generate subkeys K_1 thru K_{16}, it is necessary to perform left rotations of Ci and Di and then perform Permuted Choice 2 as shown in part 1. The number of left shifts is determined by using the iteration count, LOOPCT, as an index into the table SHIFTM. This module is relatively straightforward except for the problem caused by the half byte boundary shown in figure 13.

A second problem arises in the case of decryption. In this case, the subkeys must be generated in reverse order (ie: K16 thru K1). In order to generate them properly, the rotation of Ci and Di is done by right shifting and by using the SHIFTM table in reverse sequence and by performing Permuted Choice 2 *before* the right rotation is done. This may seem strange, but I gave it a great deal of thought to make sure it was right. It is the simplest way that I could devise to do the decryption correctly, and it works!

What's Left?

The only remaining module is the one which swaps two groups of four bytes each. This module is called SWAP, and it performs the swap function and block transform function discussed in Part 1.

Put Them All Together

The main module, DES is really a master controller for the other modules. It initializes the parameters used by TFORM, performs the appropriate modulo 2 additions shown in table 8, makes sure that subkeys are properly generated during encryption and decryption, and maintains the iteration count. Figure 14 is a general flowchart for this module.

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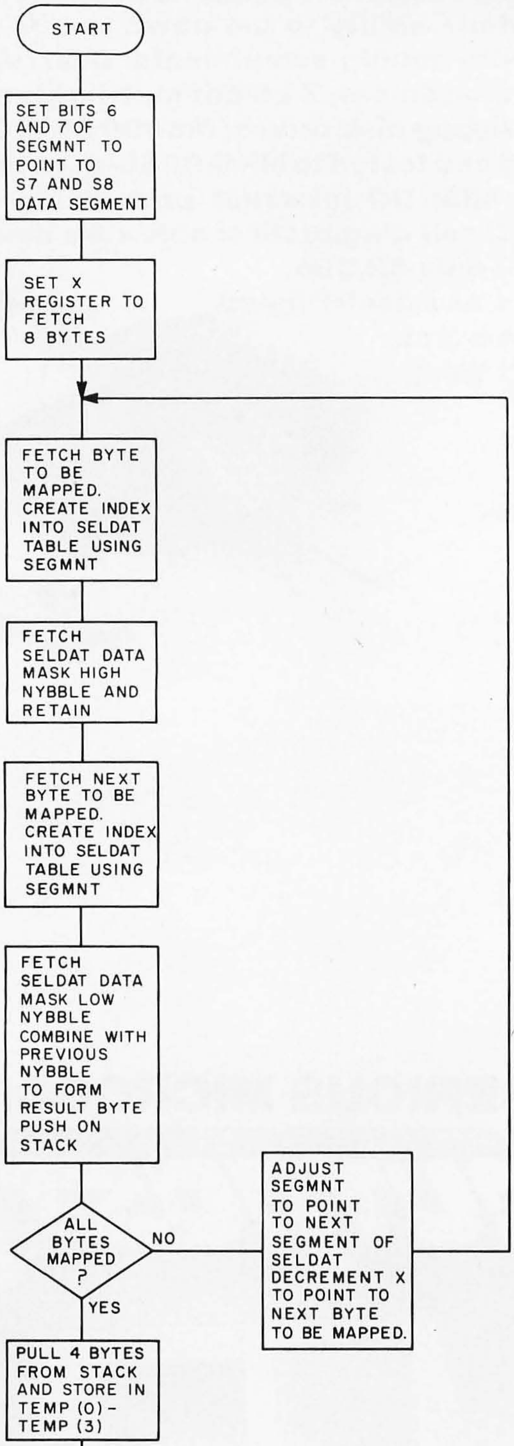


Figure 12: Flowchart of module which performs the select S1 through S8 mapping function SELECT.

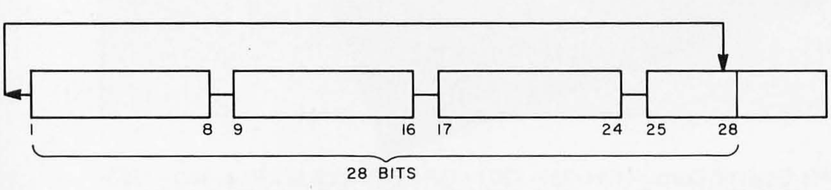


Figure 13: Rotation of the bits in Ci,Di requires special attention to bit 28 because it is in the middle of a byte.

The only particular point worth noting is that the parameters used by TFORM to perform the proper permutation are stored sequentially in the order used. The order of the information in the table DATA is:

Initial Permutation data
Permuted Choice 1 data
Permuted Choice 2 data ⎤
Select E data ⎬ 16 iterations
Permute P data ⎦
Inverse Initial Permutation data

Once the Initial Permutation and Permuted Choice 1 are performed, the DES routine sequences TFORM thru Permuted Choice 2, Select E, and Permute P, for 16 iterations. Then TFORM performs the inverse Initial Permutation to complete the encrypt or decrypt operation.

Using the Program

The Standard Data Encryption Algorithm program is written as a subroutine which can be called at hexadecimal address 0176. In order to use the routine, three things must be supplied: mode, plaintext, and key. The mode byte (location 0000) is set to 00 for encryption or FF for decryption. The plaintext is 8 bytes of data (locations 0001 thru 0008) which is to be encrypted or decrypted. The key is eight random bytes provided by you (locations 0009 thru 0010) to control the algorithm. The encrypted (or decrypted) result is returned to locations 0001 thru 0008.

A call to DES uses 12 bytes of stack storage. If your other programs use the stack, you should take care to avoid overwriting the main routine. Many of the page zero locations used by DES may be used for other purposes between calls. These hexadecimal locations are 0011 thru 002C and 0038 thru 0040. A memory map of the entire program is shown in figure 15.

When the encryption key is loaded, you should make sure that the bits are nearly as random as possible, since it is the randomness of the key which makes it difficult for an outsider to decrypt the cipher. If you attempt to load ASCII characters as key, it is likely that the most significant bit of each byte will be zero. This will substantially reduce the strength of the algorithm. An alternate way to handle the key is as 16 ASCII characters, with random contents in the four low order bits. The four low order bits of these characters can be compacted to form the eight bytes of key which the algorithm requires.

Text continued on page 124.

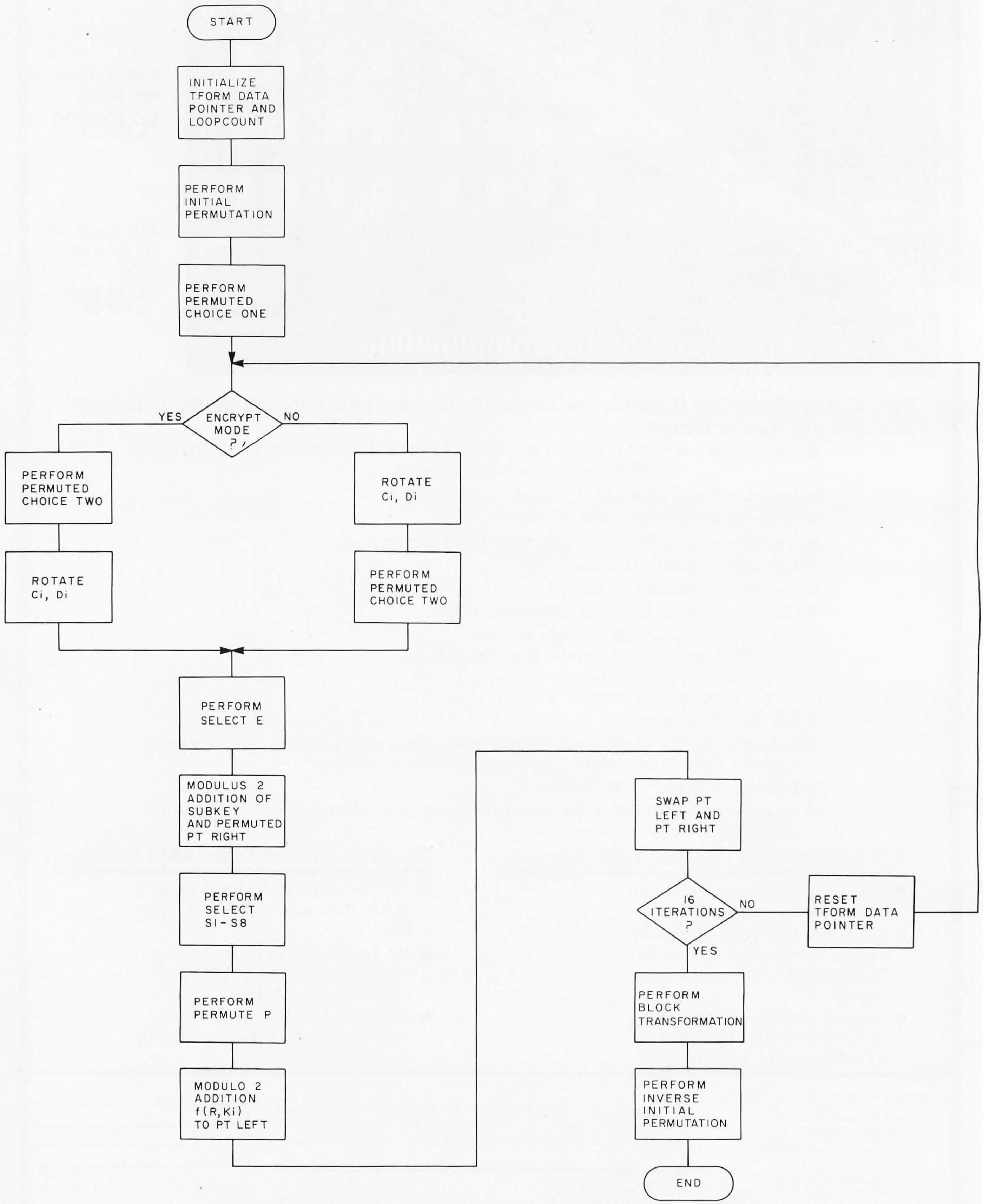


Figure 14: Flowchart of the main routine for the Standard Data Encryption Algorithm.

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000070 OBJECT-COMPUTER. MDS-800.
000080 INPUT-OUTPUT SECTION.
000090 FILE-CONTROL.
000100        SELECT STOCK-FILE ASSIGN "STOCK.IT"
000110        ORGANIZATION INDEXED
000120        ACCESS DYNAMIC
000130        RECORD KEY STOCK-CODE.
000140 DATA DIVISION.
000150 FILE SECTION.
000160 FD   STOCK-FILE; RECORD 32.
000170 01   STOCK-ITEM.
000180      02  STOCK-CODE PIC X(4).
000190      02  PRODUCT-DESC PIC X(24).
000200      02  UNIT-SIZE PIC 9(4).
000210 WORKING-STORAGE SECTION.
000220 01   SCREEN-HEADINGS.
000230      02  ASK-CODE PIC X(21) VALUE "STOCK CO
000240      02  FILLER PIC X(59).
000250      02  ASK-DESC PIC X(16) VALUE "DESCRIP
000260      02  SI-DESC PIC X(25) VALUE "
000270      02  FILLER PIC X(39).
000280      02  ASK-SIZE PIC X(21) VALUE "UNIT S
000290 01   ENTER-IT REDEFINES SCREEN-HEADINGS.
000300      02  FILLER PIC X(16).
000310      02  CRT-STOCK-CODE PIC X(4).
000320      02  FILLER PIC X(76).
000330      02  CRT-PROD-DESC PIC X(24).
000340      02  FILLER PIC X(56).
000350      02  CRT-UNIT-SIZE PIC 9(4).
000360      02  FILLER PIC X.
000370 PROCEDURE DIVISION.
000380 SR1.
000390       DISPLAY SPACE.
000400       OPEN I-O STOCK-FILE.
000410       DISPLAY SCREEN-HEADINGS.
000420 NORMAL-INPUT.
000430       MOVE SPACE TO ENTER-IT.
000440       DISPLAY ENTER-IT.
000450 CORRECT-ERROR.
000460       ACCEPT ENTER-IT.
000470       IF CRT-STOCK-CODE = SPACE GO TO END-IT.
000480       IF CRT-UNIT-SIZE NOT NUMERIC GO TO CORRECT-ERROR.
000490       MOVE CRT-PROD-DESC TO PRODUCT-DESC.
000500       MOVE CRT-UNIT-SIZE TO UNIT-SIZE.
000510       MOVE CRT-STOCK-CODE TO STOCK-CODE.
000520       WRITE STOCK-ITEM; INVALID GO TO CORRECT-ERROR.
000530       GO TO NORMAL-INPUT.
000540 END-IT.
000550       CLOSE STOCK-FILE.
000560       DISPLAY SPACE.
000570       DISPLAY "END OF PROGRAM".
000580       STOP RUN.
*  END OF LIST
```

```
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002D
002D
002D
002D

0017
001B
002F
0030
0036
004D
004E
0065
006F
0077
007D
0083
0089
0097
009A
009B
009F
00A3
00B4
```

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```
                                CLC
                                LDA   $00
                                STA   WORD 1
                                STA   WORD 2      Initialization
                                STA   WORD 3
                                 .
                                 .
                                STA   WORD 8
2 bytes     3 cycles            LDA   SOURCE 1
2 bytes     2 cycles            AND   $XX         Basic in line coding to
2 bytes     2 cycles            ADC   $FF           permute one bit
2 bytes     5 cycles            ROL   WORD 1
8 bytes     12 cycles           LDA   SOURCE 2
 total        total             AND   $XX
                                ADC   $FF
                                ROL   WORD 1
                                 .
                                 .
                                 .
```

Table 10: 6502 instructions which could be used to in line code the permutation function. Fastest time to permute one bit requires 12 cycles and 8 bytes of memory.

Key	Plain	Cipher
7CA110454A1A6E57	01A1D6D039776742	690F5B0D9A26939B
0131D9619DC1376E	5CD54CA83DEF57DA	7A389D10354BD271
07A1133E4A0B2686	0248D43806F67172	868EBB51CAB4599A
3849674C2602319E	51454B582DDF440A	7178876E01F19B2A
04B915BA43FEB5B6	42FD443059577FA2	AF37FB421F8C4095
0113B970FD34F2CE	059B5E0851CF143A	86A560F10EC6D85B
0170F175468FB5E6	0756D8E0774761D2	0CD3DA020021DC09
43297FAD38E373FE	762514B829BF486A	EA676B2CB7DB2B7A
07A7137045DA2A16	3BDD119049372802	DFD64A815CAF1A0F
04689104C2FD3B2F	26955F6835AF609A	5C513C9C4886C088
37D06BB516CB7546	164D5E404F275232	0A2AEEAE3FF4AB77
1F08260D1AC2465E	6B056E18759F5CCA	EF1BF03E5DFA575A
584023641ABA6176	004BD6EF09176062	88BF0DB6D70DEE56
025816164629B007	480D39006EE762F2	A1F9915541020B56
49793EBC79B3258F	437540C8698F3CFA	6FBF1CAFCFFD0556
4FB05E1515AB73A7	072D43A077075292	2F22E49BAB7CA1AC
49E95D6D4CA229BF	02FE55778117F12A	5A6B612CC26CCE4A
018310DC409B26D6	1D9D5C5018F728C2	5F4C038ED12B2E41
1C587F1C13924FEF	305532286D6F295A	63FAC0D034D9F793

Table 11: Sample test words for the Standard Data Encryption Algorithm.

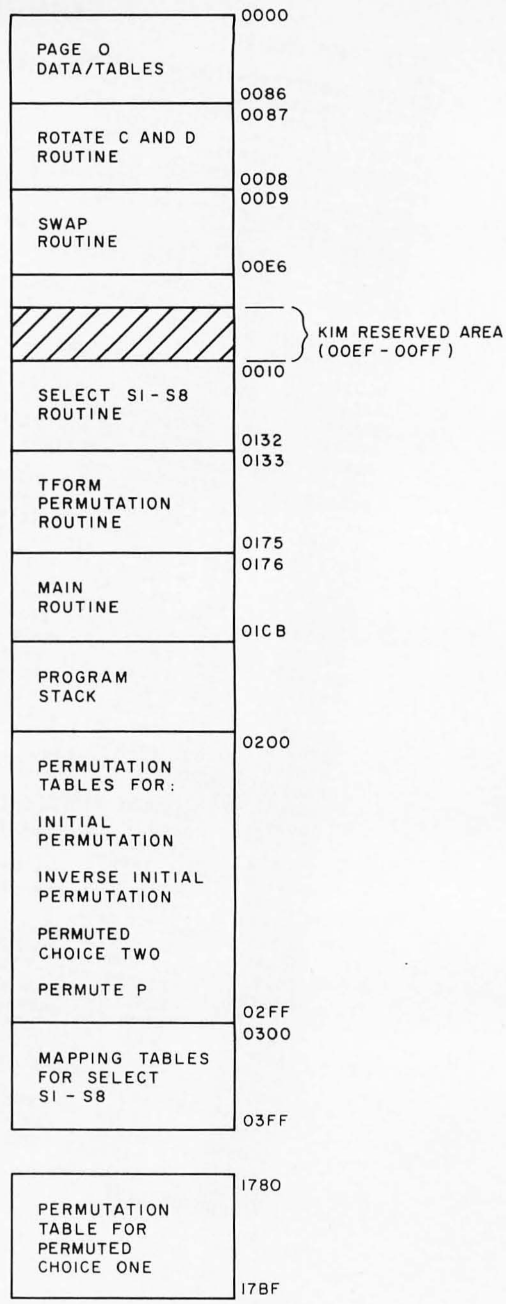


Figure 15: Memory map for the Standard Data Encryption Algorithm program.

Text continued from page 120:

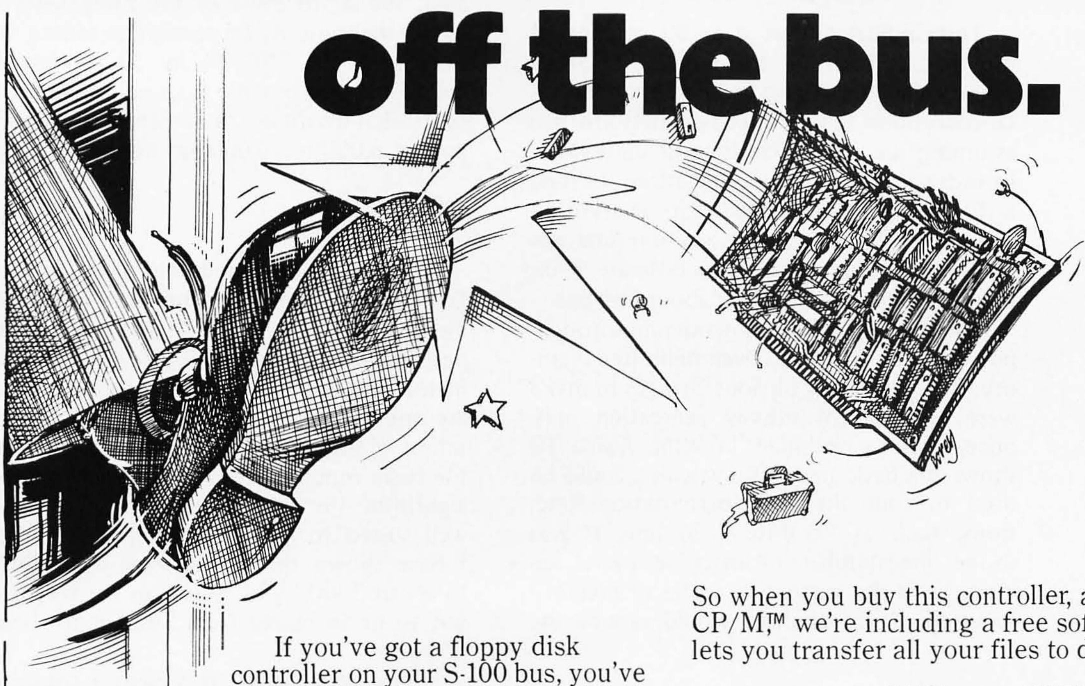
Data encrypted using the Standard Data Encryption Algorithm will be decrypted properly as long as the correct 8 byte boundaries are maintained. This allows you to independently decrypt 8 byte blocks of data in memory. There are other ways of using the encryption algorithm which require data to be decrypted in the same sequence as it was encrypted. If you are interested in adapting DES to these other techniques, you should refer to textbooks dealing with cryptography.

As a final note in using the encryption program, all of the routines, permutation and selection tables, and TFORM input parameter tables (array DATA) may be relocated by altering a small number of address references.

Timing Analysis

One of my primary objectives in programming the Standard Data Encryption Algorithm was to determine the efficiency of the 6502 processor in handling a task which requires lots of bit manipulation. In order to determine the efficiency of the implementation, I calculated the approx-

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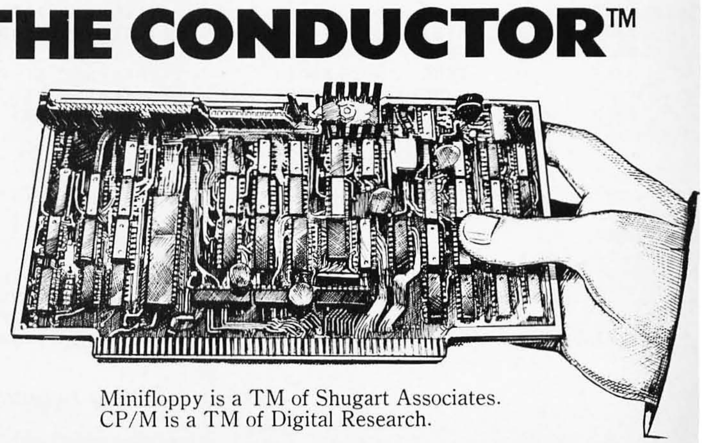
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imate number of machine cycles spent in each module during one encryption cycle. The cycle times which I used for each instruction were taken from the data provided by MOS for the 6502. My calculations revealed the following times:

DES (Main) Routine	–	4300 cycles
Rotate	–	1900 cycles
Select S1-S8	–	7500 cycles
TFORM	–	146000 cycles

This indicates that over 90 percent of the time is spent in the module TFORM. These calculations also indicate that the total encryption time is approximately 160 ms; assuming the 1 μs cycle time of the KIM-1. In order to verify these calculations, I timed a loop which performed 256 encryption operations. The observed execution time was 164 ms. Not bad for a rough estimate. Maximum throughput would be about 390 bps.

I next wondered what maximum throughput could be achieved, given unlimited memory. The two most obvious changes to make were to perform subkey generation only once, and to optimize TFORM. Table 10 shows the basic instructions which could be used to code the basic permutation functions, such as Permute P in line. It also shows the number of machine cycles required and the number of bytes of memory required. These changes would reduce the number of cycles spent in TFORM to about 16900. The time for one encryption cycle would be reduced to about 31 ms, and maximum throughput would increase to 2000 bps. Memory requirements would increase to about 3500 bytes.

It is clear that although the 6502 can perform at a reasonable rate, its instruction set is not well suited to high speed implementation of the Standard Data Encryption Algorithm. If bit test instructions were available, similar to those of the Zilog Z-80, it would theoretically be possible to reduce the time spent in TFORM by 50 percent. It would then make sense to speed up the other routines. I would not be surprised if throughputs of 8,000 to 10,000 bps were possible.

Conclusions

I have demonstrated that the Standard Data Encryption Algorithm can be implemented on the basic KIM-1 with reasonable performance. However, it is clear that the instruction sets available for most processors are not well suited to an efficient implementation of the algorithm. It is also clear that the basic functions necessary to perform the algorithm (ie: bit permutations) are not well suited to implementation in software. I have shown that an increase in memory to about 3500 bytes will allow the throughput to be increased from 390 bps to about 2000 bps.

I have attempted to present a coherent description of the Standard Data Encryption Algorithm for those readers who may be interested in reprogramming it. Table 11 provides a set of test words to verify your implementation. These test words are part of those available from National Bureau of Standards Special Publication 500-20.

The coding of my encryption program is provided in listing 1. For anyone interested in obtaining a KIM compatible cassette with the Standard Data Encryption Algorithm program, several driver routines for Teletype and keypad, a shortened version of the program, and complete documentation, send $6 to R Meushaw, 4188 Brittany Dr, Ellicott City MD 21043.

Listing 1: The DES program implemented on the basic KIM-1 module.

```
              ****************************************
              *                                      *
              *  MICRO - DATA ENCRYPTION STANDARD PROGRAM *
              *                  BY                  *
              *           ROBERT V. MEUSHAW          *
              *                                      *
              *             (ENTRY 0176)             *
              ****************************************


0087                   ORG                 $0087

                ***************
                MEMORY LOCATIONS
                ***************

0087            MODE   *    $0000          ENCRYPT/DECRYPT MODE
0087            PTL    *    $0001          PT(LEFT) START
0087            PTR    *    $0005          PT(RIGHT) START
0087            KEY    *    $0009          KEY START
0087            TEMP   *    $0011          TEMPORARY STORAGE
0087            SUBKEY *    $0019          SUBKEY START
0087            CD1    *    $0021          START OF C(I)
0087            CD2    *    $0022
0087            CD3    *    $0023
0087            CD4    *    $0024
0087            CD5    *    $0025          START OF D(I)
0087            CD6    *    $0026
0087            CD7    *    $0027
0087            CD8    *    $0028
0087            LOOPCT *    $0029          ITERATION COUNT
0087            BITCNT *    $002A          # BITS PER WORD
0087            SEGMNT *    $002A          DATA POINTER FOR S1-S8
0087            HOLD   *    $002B          TEMPORARY STORAGE
```

Listing 1 continued on next page.

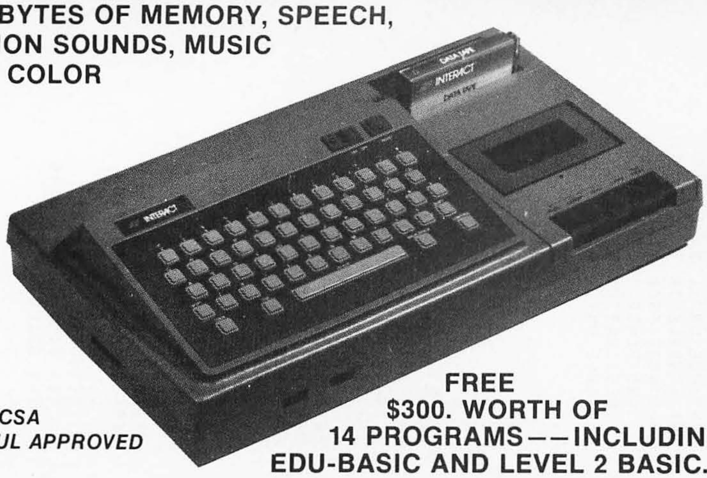
REFERENCES

Data Encryption Standard, FIPS Publication 46, US Department of Commerce/National Bureau of Standards, 1977.

Validating the Correctness of Hardware Implementations of the NBS Data Encryption Standard, NBS Special Publication 500-20, US Department of Commerce/National Bureau of Standards, 1977.

Katzan, H, *The Standard Data Encryption Algorithm,* Petrocelli Books Inc, New York, 1977.

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Listing 1, continued:

```
0087          POINT  *   $002C        POINTER FOR TFORM DATA
0087          SELDAT *   $002D        S1-S8 DATA ADDRESS
0087          MASK   *   $002F        BIT MASK ARRAY START
0087          INFO   *   $0038        START OF TFORM DATA
0087          SOURCE *   $0038        SOURCE DATA ADDRESS
0087          DEST   *   $003A        DESTINATION DATA ADDRESS
0087          PERMUT *   $003C        PERMUTE ARRAY ADDRESS
0087          PCOUNT *   $003E        PERMUTE ARRAY LENGTH
0087          BCOUNT *   $003F        # BITS PER WORD
0087          WCOUNT *   $0040        # WORDS IN DESTINATION
0087          DATA   *   $0041        DATA FOR PROPER TFORM
0087          SHIFTM *   $0077        ROTATE DATA FOR C(I),D(I)


              ********************
              ROTATE CD SUBROUTINE
              ********************

0087 A6 29    ROTATE LDX LOOPCT       PUT ITERATION # IN X
0089 24 00           BIT MODE         IF THIS IS DECRYPT, GO
008B 30 24           BMI SRIGHT          TO SHIFT RIGHT
008D B4 77           LDY SHIFTM,X     PUT SHIFT COUNT IN Y
008F A5 24    SLEFT  LDA CD4          ROTATE BITS 1-28 OF
0091 0A              ASL                 C LEFT ONE BIT
0092 26 23           ROL CD3
0094 26 22           ROL CD2
0096 26 21           ROL CD1
0098 90 02           BCC SKP1
009A 09 10           ORA $10
009C 85 24    SKP1   STA CD4
009E A5 28           LDA CD8          ROTATE BITS 1-28 OF
00A0 0A              ASL                 D LEFT ONE BIT
00A1 26 27           ROL CD7
00A3 26 26           ROL CD6
00A5 26 25           ROL CD5
00A7 90 02           BCC SKP2
00A9 09 10           ORA $10
00AB 85 28    SKP2   STA CD8
00AD 88              DEY              IF WE NEED TO SHIFT MORE
00AE D0 DF           BNE SLEFT           GO TO SHIFT LEFT
00B0 60              RTS                 ELSE RETURN
00B1 8A       SRIGHT TXA              FOR DECRYPT, ADJUST
00B2 49 0F           EOR $0F             INDEX INTO SHIFTM
00B4 AA              TAX
00B5 B4 77           LDY SHIFTM,X     PUT SHIFT COUNT IN Y
00B7 A9 10    LOOP   LDA $10          ROTATE BITS 1-28 OF
00B9 25 24           AND CD4             C RIGHT ONE BIT
00BB 18              CLC
00BC 69 FF           ADC $FF
00C2 66 23           ROR CD3
00C4 66 24           ROR CD4
00C6 A9 10           LDA $10          ROTATE BITS 1-28 OF
00C8 25 28           AND CD8             D RIGHT ONE BIT
00CA 18              CLC
00CB 69 FF           ADC $FF
00CD 66 25           ROR CD5
00CF 66 26           ROR CD6
00D1 66 27           ROR CD7
00D3 66 28           ROR CD8
00D5 88              DEY              IF WE NEED TO SHIFT MORE
```

Continued below:

```
013D B9 41 00 L5     LDA DATA,Y       LOAD NEW DATA INTO ZERO
0140 95 38           STA INFO,X          PAGE AREA (INFO).
0142 88              DEY
0143 CA              DEX
0144 10 F7           BPL L5
0146 A5 3F    L6     LDA BCOUNT       STORE # BITS PER WORD IN
0148 85 2A           STA BITCNT          BITCNT
014A A4 3E    L7     LDY PCOUNT       GET ELEMENT OF PERMUTATION
014C B1 3C           LDA (PERMUT),Y      ARRAY
014E AA              TAX              PUT COPY IN X
014F 29 07           AND $07          GET PROPER WORD #
0151 A8              TAY                 IN Y
0152 8A              TXA              RETRIEVE ARRAY ELEMENT
0153 4A              LSR                 AND ISOLATE BIT
0154 4A              LSR                 MASK #.  PUT IT IN
0155 4A              LSR                 X REG.
0156 AA              TAX
0157 B1 38           LDA (SOURCE),Y   LOAD SOURCE WORD
0159 35 2F           AND MASK,X       ISOLATE PROPER BIT
015B 18              CLC              IF BIT IS 1, GET IT INTO
015C 69 FF           ADC $FF             CARRY AND MOVE INTO
015E 26 2B           ROL HOLD            'HOLD'
0160 A5 2B           LDA HOLD         GET 'HOLD' JUST IN CASE
0162 C6 3E           DEC PCOUNT       MOVE INDEX TO NEXT PERMUTE
0164 30 04           BMI EXIT            ARRAY ELEMT. EXIT IF DONE
0166 C6 2A           DEC BITCNT       IF MORE BITS IN WORD,
0168 D0 DF           BNE L7              KEEP GOING;
016A 48       EXIT   PHA                 ELSE PUSH ON STACK
016B 10 DF           BPL L6           CONTINUE UNTIL DONE
016D A4 40           LDY WCOUNT       PUT # WORDS IN Y
016F 68       L8     PLA              PULL WORD FROM STACK
0170 91 3A           STA (DEST),Y        AND PLACE IN PROPER
0172 88              DEY                 DESTINATION WORD
0173 10 FA           BPL L8           CONTINUE UNTIL DONE
0175 60              RTS


              ********************
              DES (MAIN) SUBROUTINE
              ********************

0176 D8       DES    CLD              CLEAR DECIMAL MODE
0177 A9 FF           LDA FF           INITIALIZE DATA POINTER
0179 85 2C           STA POINT           USED BY TFORM
017B A9 0F           LDA $0F          INITIALIZE LOOP COUNT
017D 85 29           STA LOOPCT          FOR 16 ITERATIONS
017F 20 33 01        JSR TFORM        PERFORM 'IP'
0182 20 33 01        JSR TFORM        PERFORM 'PC-1'
0185 24 00    L9     BIT MODE         FOR ENCRYPT CYCLE, GET
0187 30 08           BMI SKP3            SUBKEY BY ROTATING
0189 20 87 00        JSR ROTATE          C(I) AND D(I) THEN
018C 20 33 01        JSR TFORM           PERFORM 'PC-2'. FOR
018F 30 06           BMI SKP4            DECRYPT CYCLE,
0191 20 33 01 SKP3   JSR TFORM           REVERSE THIS
0194 20 87 00        JSR ROTATE          SEQUENCE
0197 20 33 01 SKP4   JSR TFORM        PERFORM 'SELECT-E'
019A A2 07           LDX $07          PERFORM MOD 2 ADDITION
019C B5 11    L10    LDA TEMP,X          OF SUBKEY AND
019E 55 19           EOR SUBKEY,X        PERMUTED PT(RIGHT)
01A0 29 3F           AND $3F             SET BITS 6,7 TO ZERO
01A2 95 19           STA SUBKEY,X        FOR SELECT S1-S8
01A4 CA              DEX
01A5 10 F5           BPL L10
01A7 20 00 01        JSR SELECT       PERFORM 'SELECT' S1-S8
```

Continued below:

```
00D6 D0 DF          BNE LOOP          GO TO LOOP
00D8 60             RTS               ELSE RETURN

                    ********************************
                    SWAP PT(LEFT)/PT(RIGHT) SUBROUTINE
                    ********************************

00D9 A2 03          LDX #03           SET X TO EXCHANGE FOUR
00DB B5 01    L2    LDA PTL,X            BYTE PAIRS
00DD B4 05          LDY PTR,X
00DF 94 01          STY PTL,X
00E1 95 05          STA PTR,X
00E3 CA             DEX
00E4 10 F5          BPL L2            CONTINUE UNTIL FINISHED,
00E6 60             RTS       .          THEN RETURN

                    ******************************
                    SELECT FUNCTION S1-S8 SUBROUTINE
                    ******************************

0100                ORG $0100

0100 A9 C0    SELECT LDA #C0          STORE 11000000 TO ACCESS
0102 85 2A          STA SEGMNT           CORRECT DATA SEGMENT
0104 A2 07          LDX #07           SET X TO TRANSFORM 8 BYTES
0106 B5 19    L3    LDA SUBKEY,X      GET BYTE
0108 05 2A          ORA SEGMNT        ADJUST INDEX INTO SELECT
010A A8             TAY                  TRANSFORM MATRIX
010B B1 2D          LDA (SELDAT),Y    GET MATRIX DATA
010D 29 0F          AND #0F           MASK HIGH NIBBLE
010F 85 2B          STA HOLD          STORE TEMPORARILY
0111 CA             DEX               GET NEXT
0112 B5 19          LDA SUBKEY,X         BYTE
0114 05 2A          ORA SEGMNT        ADJUST INDEX INTO SELECT
0116 A8             TAY                  TRANSFORM MATRIX
0117 B1 2D          LDA (SELDAT),Y    GET MATRIX DATA
0119 29 F0          AND #F0           MASK LOW NIBBLE
011B 05 2B          ORA HOLD          COMBINE WITH PREVIOUS DATA
011D 48             PHA                  AND PUSH ON STACK
011E A5 2A          LDA SEGMNT        ADJUST POINTER INTO
0120 38             SEC                  CORRECT DATA
0121 E9 40          SBC #40              SEGMENT
0123 85 2A          STA SEGMNT
0125 CA             DEX               CONTINUE UNTIL ALL
0126 10 DE          BPL L3               BYTES TRANSFORMED
0128 A2 00          LDX #00
012A 68       L4    PLA               PULL FOUR BYTES FROM
012B 95 11          STA TEMP,X           STACK AND PUT INTO
012D E8             INX                  TEMP(0)-TEMP(3)
012E E0 04          CPX #04
0130 D0 F8          BNE L4
0132 60             RTS

                    **************************
                    TFORM PERMUTATION SUBROUTINE
                    **************************

0133 A5 2C    TFORM LDA POINT         LOAD OLD POINTER TO DATA USED
0135 18             CLC                  BY TFORM. UPDATE POINTER
0136 69 09          ADC #09              TO GET NEXT SET OF DATA -
0138 85 2C          STA POINT            SOURCE ADDR, DEST ADDR,
013A A8             TAY                  PERMUTE ARRAY ADDR, #BITS,
013B A2 08          LDX #08              #WORDS, ARRAY LENGTH.

01AA 20 33 01       JSR TFORM         PERFORM 'PERMUTE-P'
01AD A2 03          LDX #03           PERFORM MOD 2 ADDITION
01AF B5 01    L11   LDA PTL,X            OF PT(LEFT) AND
01B1 55 11          EOR TEMP,X           F( PT(RIGHT) )
01B3 95 01          STA PTL,X         STORE IN PT(LEFT)
01B5 CA             DEX
01B6 10 F7          BPL L11
01B8 20 D9 00       JSR SWAP          EXCHANGE PTL AND PTR
01BB C6 29          DEC LOOPCT        DECREMENT LOOP COUNT,
01BD 30 06          BMI FIN              EXIT IF DONE
01BF A9 11          LDA #11              ELSE ADJUST POINTER
01C1 85 2C          STA POINT            FOR TFORM ROUTINE
01C3 D0 C0          BNE L9               AND CONTINUE
01C5 20 D9 00 FIN   JSR SWAP          PERFORM 'BLOCK' TRANSFORM
01C8 20 33 01       JSR TFORM         PERFORM 'IP(INVERSE)'
01CB 60             RTS               DES COMPLETED

                    ***********
                    PROGRAM DATA
                    ***********

002D 00 03                            ADDR OF S1-S8 DATA
002F 00                               BIT MASK TO FORCE 0
0030 80                               BIT 1 MASK
0031 40                               BIT 2 MASK
0032 20                               BIT 3 MASK
0033 10                               BIT 4 MASK
0034 08                               BIT 5 MASK
0035 04                               BIT 6 MASK
0036 02                               BIT 7 MASK
0037 01                               BIT 8 MASK
0041 01 00                            IP DATA: SOURCE ADDR
0043 01 00                                     DEST ADDR
0045 00 02                                     PERMUTE ADDR
0047 3F                                        -LENGTH
0048 08                                        DEST BITS/WORD
0049 07                                        DEST # BYTES
004A 09 00                            PC-1 DATA:
004C 21 00
004E 80 17
0050 3F
0051 08
0052 07
0053 21 00                            PC-2 DATA:
0055 19 00
0057 80 02
0059 2F
005A 06
005B 07
005C 05 00                            SELECT-E DATA:
005E 11 00
0060 B0 02
0062 2F
0063 06
0064 07
0065 11 00                            PERMUTE-P DATA:
0067 11 00
0069 E0 02
006B 1F
006C 08
006D 03
006E 01 00                            IP(INVERSE) DATA:
0070 01 00
```

Listing 1 continued on next page.

Listing 1, continued:

```
0072 40 02
0074 3F
0075 08
0076 07
0077 01 02 02 02 02 02 02 01     SHIFTM DATA FOR
007F 02 02 02 02 02 02 01 01        C,D SHIFT

0200 38 39 3A 3B 3C 3D 3E 3F     IP TABLE
0208 28 29 2A 2B 2C 2D 2E 2F
0210 18 19 1A 1B 1C 1D 1E 1F
0218 08 09 0A 0B 0C 0D 0E 0F
0220 40 41 42 43 44 45 46 47
0228 30 31 32 33 34 35 36 37
0230 20 21 22 23 24 25 26 27
0238 10 11 12 13 14 15 16 17

0240 0B 0F 0A 0E 09 0D 08 0C     IP(INVERSE) TABLE
0248 13 17 12 16 11 15 10 14
0250 1B 1F 1A 1E 19 1D 18 1C
0258 23 27 22 26 21 25 20 24
0260 2B 2F 2A 2E 29 2D 28 2C
0268 33 37 32 36 31 35 30 34
0270 3B 3F 3A 3E 39 3D 38 3C
0278 43 47 42 46 41 45 40 44

0280 24 0C 44 36 35 16 0F 34     PC-2 TABLE
0288 27 1D 2E 45 26 2C 0E 3E
0290 25 14 1F 1E 0D 1C 46 2D
0298 10 29 22 1B 38 41 40 13
02A0 20 21 1A 3A 11 2A 30 39
02A8 23 18 28 08 42 19 0A 31

02B0 08 43 3B 33 2B 23 2B 23     SELECT-E TABLE
02B8 1B 13 0B 42 0B 42 3A 32
02C0 2A 22 2A 22 1A 12 0A 41
02C8 0A 41 39 31 29 21 29 21
02D0 19 11 09 40 09 40 38 30
02D8 28 20 28 20 18 10 08 43

02E0 0B 20 19 32 30 33 29 1A     PERMUTE-P TABLE
02E8 09 18 1B 43 31 42 40 10
02F0 11 3B 12 28 13 3A 39 08
02F8 0A 23 21 2B 2A 22 38 41

1780 00 00 00 00 20 21 22 23     PC-1 TABLE
1788 28 29 2A 2B 2C 2D 2E 2F
1790 30 31 32 33 34 35 36 37
1798 38 39 3A 3B 3C 3D 3E 3F
17A0 00 00 00 00 24 25 26 27
17A8 18 19 1A 1B 1C 1D 1E 1F
17B0 10 11 12 13 14 15 16 17
17B8 08 09 0A 0B 0C 0D 0E 0F

0300 EF 03 41 FD D8 74 1E 47     SELDAT (SELECT S1-S8 DATA)
0308 26 EF FB 22 B3 D8 84 1E
0310 39 AC A7 60 62 C1 CD BA
0318 5C 96 90 59 05 3B 7A 85
0320 40 FD 1E C8 E7 8A 8B 21
0328 DA 43 64 9F 2D 14 B1 72
0330 F5 5B C8 B6 9C 37 76 EC
0338 39 A0 A3 05 52 6E 0F D9
0340 A7 DD 0D 78 9E 0B E3 95
0348 60 36 36 4F F9 60 5A A3
0350 11 24 D2 87 C8 52 75 EC
0358 BB C1 4C BA 24 FE 8F 19
0360 DA 13 66 AF 49 D0 90 06
0368 8C 6A FB 91 37 8D 0D 78
0370 BF 49 11 F4 23 E5 CE 3B
0378 55 BC A2 57 E8 22 74 CE
0380 2C EA C1 BF 4A 24 1F C2
0388 79 47 A2 7C B6 D9 68 15
0390 80 56 5D 01 33 FD F4 AE
0398 DE 30 07 9B E5 83 9B 68
03A0 49 B4 2E 83 1F C2 B5 7C
03A8 A2 19 D8 E5 7C 2F 83 DA
03B0 F7 6B 90 FE C4 01 5A 97
03B8 61 A6 3D 40 0B 58 E6 3D
03C0 4D D1 B2 0F 28 BD E4 78
03C8 F6 4A 0F 93 8B 17 D1 A4
03D0 3A EC C9 35 93 56 7E CB
03D8 55 20 A0 FE 6C 89 17 62
03E0 17 62 4B B1 B4 DE D1 87
03E8 C9 14 3C 4A 7E A8 E2 7D
03F0 A0 9F F6 5C 6A 09 8D F0
03FF 0F E3 53 25 95 36 28 CB
```
■



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Queuing Theory, the Science of Wait Control

Part 1: Queue Representation

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POB 96 RD 1
Clarks Summit PA 18411

How many times have you waited in a line? Do you always get to a supermarket checkout counter without having to wait? Is the pump at the gas station always open and ready for you as you drive into the service area? It's difficult to imagine anyone going anywhere and not having to wait in a line.

Since we're computer oriented, let's define a waiting line by its proper name — that is, a queue.

A queue is a waiting line controlled by some service mechanism. A customer enters a queue at the *tail* of the queue, waits in line until he or she arrives at the *head* of the queue, is serviced at the head of the queue, and, finally, leaves the queue. At the supermarket a customer pushes a cart to one of the lines formed at the checkout area and waits in a line until finally arriving at the cash register at the head of that line. After checking out the purchases, that customer leaves the queue.

Queue Examples

Other examples of queues can be found in many areas of our everyday lives. The supermarket checkout queue is a commercial type of queuing system. Other commercial queues include the bank teller queue, the barbershop queue, the gas station queue, etc. The field of transportation is not without its share of queues: traffic lights, turnpike toll booths, airport runways, loading and unloading docks are but a few examples.

Of course, we have personal queues. How about that shelf of books you're planning to read some day?

Let's Have Order

A queue is defined as a waiting line, and since a waiting line has both a beginning (tail) and an end (head), a queue must also have both these properties.

The head and tail idea implies that customers entering (being inserted) or leaving (being deleted) must follow a definite ordering scheme as members of the queue. This ordering scheme is defined as the dispatching discipline of the queue.

The usual dispatching discipline of a queue is known as *first in first out* or *FIFO.* An orderly queue exhibits this scheme. The first person entering the queue is the first person to receive service, and the last person entering the queue is the last person to receive service. Any person entering after the first but before the last must spend some time waiting in the queue before service may be rendered.

The first in first out discipline is but one of many ordering schemes that queues follow. Other servicing disciplines include last in first out (eg: a stack of dishes), a priority queue, and shortest line first or longest line first (these are multiple queuing systems and will be discussed later).

Queue Representation

How can we represent a queue as part of a computer program? The following piece of BASIC coding (a one-dimensional array) could be used to represent a queue in a computer program:

```
10 DIM Q(100).
```

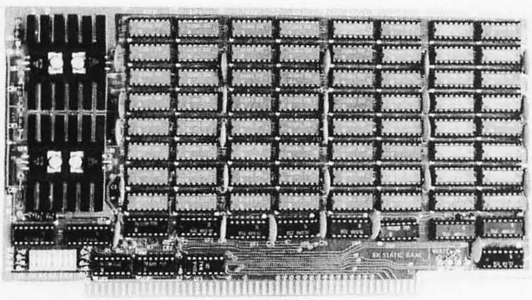
A queue is nothing more than a special purpose one-dimensional array. Just as the ordinary one-dimensional array is represented as a single row or a single column structure *n* locations long or deep, the queue can be represented as a single row structure *n* locations long.

Over and Under

When an array is dimensioned to 100 locations, the program cannot access the

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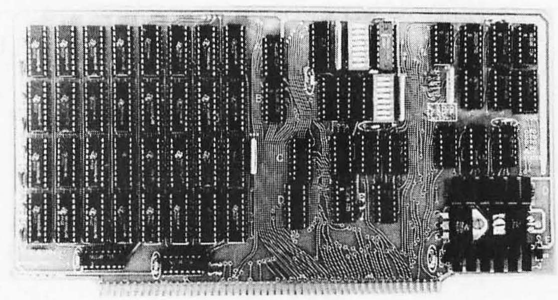


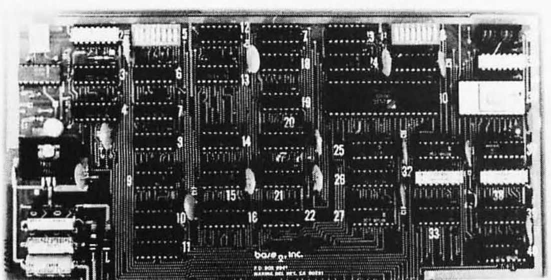
8K Static Memory Board

This 8K board is available in two versions. The 8KS-B operates at 450ns for use with 8080 and 8080A microprocessor systems and Z-80 systems operating at 2MHz. The 8KS-Z operates at 250ns and is suitable for use with Z-80 systems operating at 4MHz. Both kits feature factory fresh 2102's (low power on 8KS-B) and includes sockets for all IC's. Support logic is low power Schottky to minimize power consumption. Address and data lines are fully buffered and 4K bank addressing is DIP switch selectable. Memory Protect/Unprotect, selectable wait states and battery backup are also designed into the board. Circuit boards are solder masked and silk-screened for ease of construction. These kits are the best memory value on the market! Available from stock . . . **8KS-B $125** (assembled and tested add $25.00)
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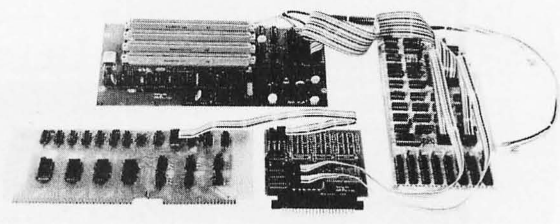


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Listing 1: Simple BASIC simulation of a row queue. Pseudorandom number generation is done to ensure that the queue simulation works correctly as described in the text. A sample run of the program is also shown.

```
1000      DIM Q(5)
1001 REM
1002 REM INITIALIZE QUEUE TO EMPTY STATE
1003 REM
1010      FOR J2 = 1 TO 5
1020      Q(J2) = -9
1030      NEXT J2
1031 REM
1032 REM INITIALIZE TAIL TO HEAD OF QUEUE
1033 REM
1040      T = 5
1041 REM
1042 REM START OF MAIN SIMULATION LOOP
1043 REM
1050      FOR J2 = 1 TO 15
1051 REM
1052 REM GENERATE A RANDOM NUMBER TO DETERMINE
1053 REM AN INSERTION WHEN N <= 5
1054 REM  A  DELETION WHEN N >= 6
1055 REM
1060      N = INT ( RND (1) * 10 ) + 1
1070      PRINT "NUMBER="; N;
1080      IF N <= 5 GOSUB 1170
1090      IF N >= 6 GOSUB 1240
1091 REM
1092 REM PRINT QUEUE CONTENTS
1093 REM PRINT TAIL POINTER VALUE
1094 REM
1100      PRINT " QUEUE=";
1110      FOR J3 = 1 TO 5
1120      PRINT Q(J3);
1130      NEXT J3
1140      PRINT " TAIL="; T
1141 REM
1142 REM END OF MAIN SIMULATION LOOP
1143 REM
1150      NEXT J2
1160      STOP
1161 REM
1162 REM   I N S E R T I O N   R O U T I N E
1163 REM
1164 REM WHEN T = 0 QUEUE IS FULL, I.E. OVERFLOW
1165 REM ELSE, INSERT N AT TAIL AND DECREMENT TAIL
```

104th or −36th location. These integer values are not within the boundaries of the dimensioning statement. If the program attempts to address out of range locations during execution of the program, an *overflow* or *underflow* condition occurs. Overflow occurs when a location greater than that given in the dimensioning statement is addressed. Likewise, underflow occurs when a negative subscript is given as an addressing value.

Some BASIC interpreters allow for addressing location 0 of an array. If an array is dimensioned to 100 locations, the actual number of legally addressable locations is 101 (counting location 0 as the first available location).

The program listings in this article do not take advantage of this extra available array location. The first available location is always array location 1, and the last available location is equal to the integer value given in the dimensioning statement.

Let's get back to overflow and underflow as these conditions apply to queues. If we assume that our queuing program will not address a location above or below those given in the dimensioning statement, overflow and underflow take on a somewhat different meaning.

A queue overflow occurs when the program attempts to insert an item into our queue and the queue is filled to its capacity. Underflow in a queue structure occurs when the program attempts to delete an item from the queue but there are no items in the queue.

Queue Operations

Items in an ordinary one-dimensional array can have many operations performed

on them. A program can insert items anywhere within the array, and items can be removed from any legal location within the array. Items can be examined and left in place or moved to any location within an array.

A queue can have only two operations performed upon its items. The first of these allowable operations is the insertion of an item into the queue. This insertion can be done only at the tail of the queue. The second operation allows for deletion. Deletion is done only at the head of the queue.

The Simple Row Queue

The program shown in listing 1 is a simulation of a *row* queue (see figure 1). The mechanics of a row queue follow the definitions we have seen so far.

The row queue has its tail at location 1 of array Q, while its head is at location 5 of array Q. The choice of these locations for tail and head is arbitrary. I chose this scheme

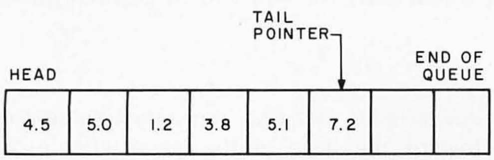


Figure 1: Simple row queue. This type of queue has a stationary "head" and a moving "tail." As data items are deleted from the head, all of the data items in the queue are moved toward the head, and the tail pointer is decremented by 1. As more data is entered into the queue at the tail, the location of the tail pointer is incremented by one location.

Listing 1, continued:

```
1166 REM
1170      IF T = 0 GOTO 1220
1180      PRINT " INSERTION";
1190      Q(T) = N
1200      T = T - 1
1210      RETURN
1220      PRINT " OVERFLOW ";
1230      RETURN
1231 REM
1232 REM   D E L E T I O N   R O U T I N E
1233 REM
1234 REM WHEN T = 5 QUEUE IS EMPTY, I.E. UNDERFLOW
1235 REM ELSE, DELETE N AT HEAD OF QUEUE
1236 REM AND MOVE REMAINING ITEMS TOWARD HEAD
1237 REM
1240      IF T = 5 GOTO 1350
1250      PRINT " DELETION ";
1260      T = T + 1
1270      FOR J4 = 5 TO T STEP -1
1280      IF J4 = 1 GOTO 1330
1290      J5 = J4 - 1
1300      Q(J4) = Q(J5)
1310      NEXT J4
1320      RETURN
1330      Q(1) = -9
1340      RETURN
1350      PRINT " UNDERFLOW";
1360      RETURN
1370 END
RUN
NUMBER= 7 UNDERFLOW QUEUE=-9 -9 -9 -9 -9 TAIL= 5
NUMBER= 3 INSERTION QUEUE=-9 -9 -9 -9  3 TAIL= 4
NUMBER= 7 DELETION  QUEUE=-9 -9 -9 -9 -9 TAIL= 5
NUMBER= 4 INSERTION QUEUE=-9 -9 -9 -9  4 TAIL= 4
NUMBER= 1 INSERTION QUEUE=-9 -9 -9  1  4 TAIL= 3
NUMBER= 3 INSERTION QUEUE=-9 -9  3  1  4 TAIL= 2
NUMBER= 2 INSERTION QUEUE=-9  2  3  1  4 TAIL= 1
NUMBER= 5 INSERTION QUEUE= 5  2  3  1  4 TAIL= 0
NUMBER= 2 OVERFLOW  QUEUE= 5  2  3  1  4 TAIL= 0
NUMBER= 8 DELETION  QUEUE=-9  5  2  3  1 TAIL= 1
NUMBER= 7 DELETION  QUEUE=-9 -9  5  2  3 TAIL= 2
NUMBER= 8 DELETION  QUEUE=-9 -9 -9  5  2 TAIL= 3
NUMBER= 3 INSERTION QUEUE=-9 -9  3  5  2 TAIL= 2
NUMBER= 4 INSERTION QUEUE=-9  4  3  5  2 TAIL= 1
NUMBER= 9 DELETION  QUEUE=-9 -9  4  3  5 TAIL= 2
```

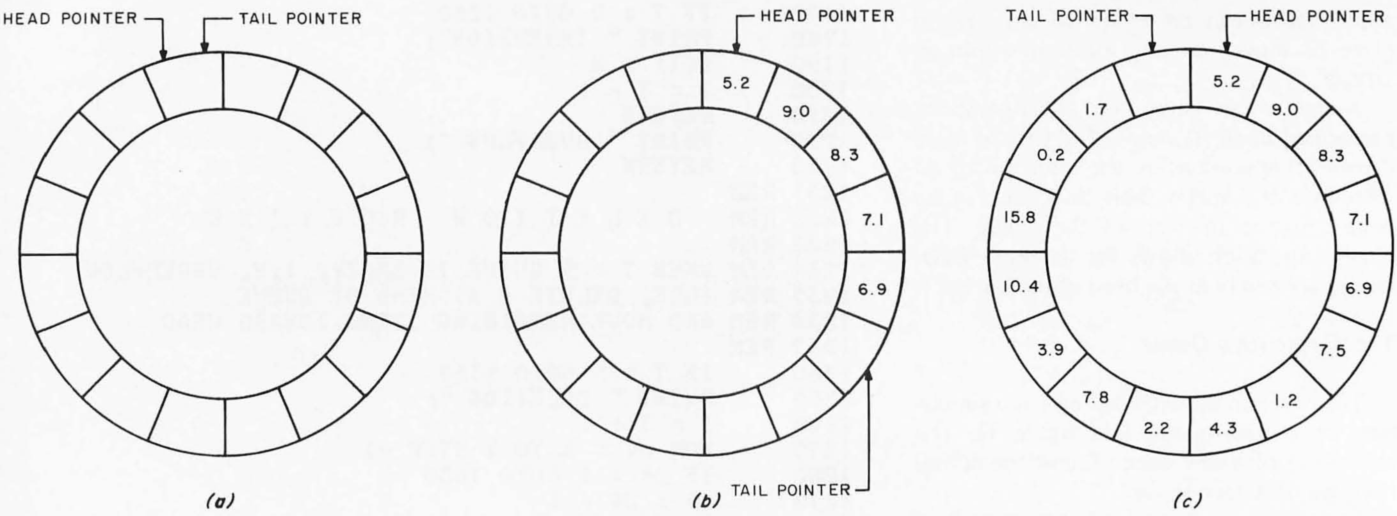


Figure 2: Circular queue in three states of use. Figure 2a is an empty queue, in which the head pointer and the tail pointer point to the same location in the queue. Figure 2b shows a partially filled circular queue. The tail pointer moves ahead of the head pointer as data items are added to the queue. As an item is deleted, the head pointer moves towards the tail pointer. Figure 2c shows a full queue. In this state the tail pointer has caught up with the head pointer. Note that one location in the queue will be left empty. If this were not done, the next item added to the queue would make the head and tail pointers point to the same location, which would seem to indicate that the queue was empty.

because it is easier to output the queue during execution of the program in a normal left-to-right reading fashion.

The head (service facility area) of the queue of listing 1 is always at location Q(5). The tail of the queue (the location in the queue where items will be inserted) moves from location 5 toward location 0 of array Q as items are inserted into the queue. When items are deleted, the tail of the queue moves from its present value toward location 5.

The tail of the row queue is indicated by a tail pointer (variable T). When T is 5 the queue is empty: that is, there are no items in the queue. When T is 0 the queue is filled to its capacity and no insertions can be made without causing an overflow condition.

To simulate the action of a queue properly, listing 1 generates pseudorandom numbers to determine queue insertion or deletion. The importance of randomness in proper queue operation is explained later.

Before you execute the program in listing 1, run through its operations with pencil and paper. This approach will show you how the program will *run* before the actual operation is simulated by the computer. This method will also clarify the mechanics of a simple row queue operation.

The Circular Queue

A major disadvantage of our simple row queue is the fact that items must be moved toward the head of the queue after each deletion. [**Editor's Note:** *This is not true for all implementations of a row queue. Often, the pointers indicating the head and tail of the row queue are moved instead of all the data inside the queue. . . .***RGAC**] The loop in line numbers 1370 through 1400 of listing 1 accomplishes this move. If we're trying to represent a queue simulation in a computer program, why not use some programming techniques to take advantage of decreasing execution time and thereby eliminate some of the unwieldy code?

The circular queue, figure 2, is also represented as a special purpose one-dimensional array. The simple row queue has a pointer to keep track of the location where the next item insertion was to take place. The circular queue also has this tail pointer.

The difference between the row and circular queue lies in the addition of another pointer to indicate the location of the head of the queue. The simple row queue always has its head at the last available location of the array Q. The circular queue structure can have its head anywhere within the queue.

Circular Queue Representation

The circular queue operates in the same manner as the simple row queue. Items are still inserted into the location given as the tail point location of array Q.

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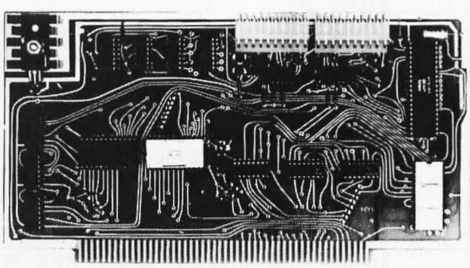
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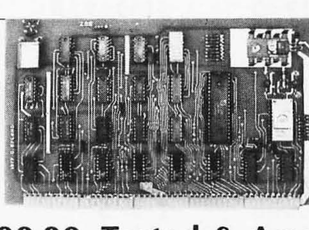
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Listing 2: BASIC listing for a circular queue simulation. Lines 1900 through 2100 are the insertion routine; lines 2110 through 2270 are the deletion routine. A sample run of the program is shown at the end of the listing.

```
1000      DIM Q(5)
1001 REM
1002 REM INITIALIZE QUEUE TO EMPTY STATE
1003 REM
1010      FOR J2 = 1 TO 5
1020      Q(J2) = -9
1030      NEXT J2
1031 REM
1032 REM INITIALIZE HEAD AND TAIL POINTERS
1033 REM TO HEAD OF QUEUE LOCATION
1034 REM
1040      H = 5
1050      T = 5
1051 REM
1052 REM START OF MAIN SIMULATION LOOP
1053 REM
1060      FOR J3 = 1 TO 10
1061 REM
1062 REM GENERATE A RANDOM NUMBER TO DETERMINE
1063 REM AN INSERTION WHEN N <= 5
1064 REM  A DELETION  WHEN N >= 6
1065 REM
1070      N = INT ( RND (1) * 10 ) + 1
1080      IF N <= 5 GOSUB 1900
1090      IF N >= 6 GOSUB 2110
1091 REM
1092 REM PRINT QUEUE CONTENTS
1093 REM PRINT TAIL AND HEAD POINTER VALUES
1094 REM
1100      FOR J4 = 1 TO 5
1110      PRINT Q(J4);
1120      NEXT J4
1130      PRINT " TAIL AT"; T; " HEAD AT"; H
1131 REM
1132 REM END OF MAIN SIMULATION LOOP
1133 REM
1140      NEXT J3
1150      STOP
1151 REM
1152 REM   I N S E R T I O N   R O U T I N E
1153 REM
1154 REM CHECK TAIL AND HEAD POINTER VALUES
1155 REM
1900      IF H = T GOTO 1970
1910      IF H < T GOTO 2030
1920      IF T >= 1 GOTO 2030
1930      IF H = 5 GOTO 2080
1931 REM
1932 REM INSERT ITEM AT Q(H)
1933 REM SINCE QUEUE IS EMPTY
1934 REM
1940      Q(5) = N
1950      T = 4
1960      GOTO 2050
1970      IF T <> 0 GOTO 2000
1971 REM
1972 REM RESET POINTERS TO HEAD OF QUEUE
1973 REM
1980      H = 5
1990      T = 5
1991 REM
1992 REM CHECK IF Q(T) EMPTY FOR POSSIBLE INSERT
1993 REM
2000      IF Q(T) <> -9 GOTO2080
2010      H = 5
2020      T = 5
```

Listing 2 continued on page 140.

The major difference is in the way which the program controls the head location of the queue. A new variable called H (for head pointer) points to the array location which holds the item ready for deletion.

An item is inserted into the queue at the location pointed to by the tail pointer. After this insertion, the pointer is moved by one location in readiness for another insertion. When an item is deleted, the head pointer comes into play. In the simple row queue, the head is always at the last available location. In the circular queue, the head of the queue is defined by the value of the head pointer variable H. After an item is deleted, the head pointer is moved one location toward the value of the tail pointer. In this structure, data items remain stationary; only the pointers vary, indicating relative positions of the tail and the head of the queue.

This queue structure is clearly advantageous when we're dealing with long queues. If a row queue is filled to its capacity and an item is deleted, every remaining item has to be moved one at a time toward the stationary head of the row queue. The circular queue moves the head pointer by only one location, thereby cutting program execution time.

The tradeoff is time versus space. The circular queue program is longer than the simple row queue; however, the time to execute the circular queue routine is shorter since the majority of code execution in the simple row queue is during the moving of the items after a delete operation.

In the circular queue, the tail pointer chases the head pointer during insertions. During deletions, the head pointer chases the tail pointer.

When the circular queue is filled to capacity, the head and tail pointers are at adjacent locations. No more items may be inserted simply because there is no more available space to fit an item into the queue. An overflow condition occurs if an insertion is attempted on a filled queue.

An underflow occurs when the queue is empty and a deletion is attempted. An empty circular queue is one in which the tail and the head pointers are at the same location in the array Q.

The program given in listing 2 simulates a circular queue. Again, a pencil and paper method of initial execution may prove helpful. After the mechanics of this structure are understood, then execute the program.

This completes our discussion of two different types of queues and their representation in a computer. In part 2 we will consider queues in the world around us and fit them into the structures already developed.

Listing 2, continued:

```
2021 REM
2022 REM NORMAL TAIL INSERTION
2023 REM
2030      Q(T) = N
2040      T = T - 1
2050      PRINT " "
2060      PRINT "ARRIVAL"
2070      RETURN
2080      PRINT " "
2090      PRINT "OVERFLOW"
2100      RETURN
2101 REM
2102 REM   D E L E T I O N   R O U T I N E
2103 REM
2104 REM CHECK POINTER VALUES FOR POSSIBLE DELETE
2105 REM
2110      IF H = T GOTO 2150
2120      IF H > 0 GOTO 2190
2130      H = 5
2140      GOTO 2180
2150      IF H <> 0 GOTO 2180
2160      H = 5
2170      T = 5
2171 REM
2172 REM DELETE FROM Q(H) IF Q(H) HAS AN ITEM
2173 REM ELSE, QUEUE IS EMPTY, I.E. UNDERFLOW
2174 REM
2180      IF Q(H) = -9 GOTO 2240
2190      Q(H) = -9
2200      H = H - 1
2201 REM
2202 REM RESET POINTERS FOR NEXT DELETE
2203 REM
2210      IF H <> 0 GOTO 2260
2220      H = 5
2230      RETURN
2240      PRINT " "
2250      PRINT "UNDERFLOW"
2260      RETURN
2270 END

RUN

ARRIVAL
-9 -9 -9 -9  3 TAIL AT 4 HEAD AT 5

ARRIVAL
-9 -9 -9  2  3 TAIL AT 3 HEAD AT 5

ARRIVAL
-9 -9  4  2  3 TAIL AT 2 HEAD AT 5
-9 -9  4  2 -9 TAIL AT 2 HEAD AT 4

ARRIVAL
-9  5  4  2 -9 TAIL AT 1 HEAD AT 4

ARRIVAL
 3  5  4  2 -9 TAIL AT 0 HEAD AT 4

ARRIVAL
 3  5  4  2  1 TAIL AT 4 HEAD AT 4

OVERFLOW

 3  5  4 -9  1 TAIL AT 4 HEAD AT 3

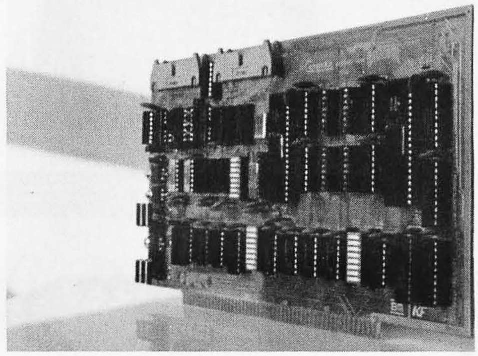
ARRIVAL
 3  5  4  3  1 TAIL AT 3 HEAD AT 3
```
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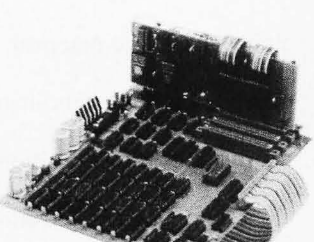
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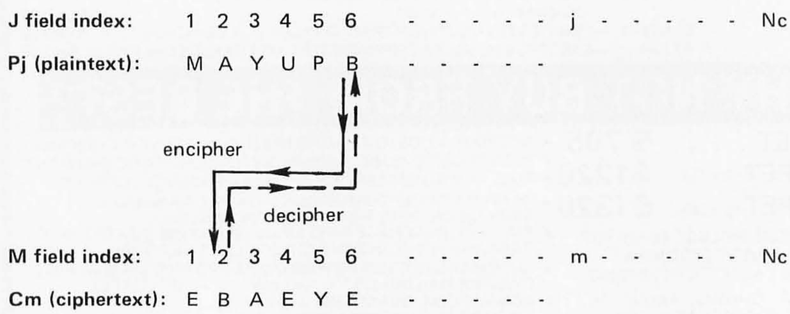


Table 8: A transposition mode operation using program Crypto. In this example the number displayed by the calculator (J.M) is 6.002. When enciphering, this means that the character in position 6 of the plaintext is placed in position 2 of the ciphertext. If this were deciphering, the character in position 2 of the ciphertext would be placed in position 6 of the plaintext.

Alphabetical Order		Numerical Order	
(1)	(2)	(3)	(4)
A	07	01	F
B	02	02	B
C	26	03	T
D	23	04	L
E	08	05	Z
F	01	06	X
G	09	07	A
H	13	08	E
I	11	09	G
J	15	10	Y
K	20	11	I
L	04	12	Q
M	22	13	H
N	14	14	N
O	16	15	J
P	19	16	O
Q	12	17	S
R	25	18	W
S	17	19	P
T	03	20	K
U	21	21	U
V	24	22	M
W	18	23	D
X	06	24	V
Y	10	25	R
Z	05	26	C

Table 9: Mixed alphabet used in the examples. Column 2 was derived from program Crypto using values of A: 0.5, 1.625, 3.125, 26 and R/S:0.

As mentioned in part 1 of this article (March 1979 BYTE, page 56), a field cipher is a technique for encoding plaintext so that it can be easily decoded with pencil and paper (or calculator) in the field, so to speak. The calculator program of listing 1 when used with the procedures described offers the user an effective field cipher capability. Unlike most field cipher machines, which perform substitution only, the program Crypto (listing 1) offers both transposition and substitution. The transposition operation is mandatory and provides the main strength of the cipher. Substitution may be added for further protection if desired. The basic principles of operation are first described, including detailed instructions for usage. Following this, a discussion of program organization is given.

Since Crypto performs both transposition and (optionally) substitution, a transposition table and substitution key are involved in the processing of each character. It is convenient to define a few terms:

- Na — alphabet size (no practical limit);
- Nc — number of characters in message (300 maximum);
- J — plaintext character position (1, 2, . . ., Nc);
- M — ciphertext character position (1, 2, . . ., Nc);
- P — plaintext character (A, B, C, . . .);
- $\overline{P}$ — plaintext character value;
- C — ciphertext character (A, B, C, . . .);
- $\overline{C}$ — ciphertext character value;
- K — key value used in substitution process.

The program uses a random number generator which must be initialized with a *seed*, R0, and two parameters, A1 and A2. These three numbers plus the character count are entered into the stack, after which A is depressed. One more number completes the entry, after which R/S is depressed. The

in the Field Calculator

demonstration numerical key is: R0 = 0.5; A1 = 1.625; and A2 = 3.125.

Transposition Only Mode

The character manipulations for transposition only are illustrated in table 8. The top two rows, an index row and a plaintext character row, are concerned with plaintext. The bottom two rows are ciphertext index and ciphertext. Each time Crypto is cycled, a pair of integers is displayed in the format:

J.M

and are interpreted in the enciphering operation as "plaintext character from position J goes to ciphertext position M." Number J is simply indexed every cycle (1, 2, . . ., Nc). Crypto produces the M values randomly in the range 1 to Nc with no repetitions (transposition table). For the cycle illustrated in table 8, the display shows 6.002, which requires that the B from J = 6 be moved to M = 2. By this means the plaintext characters are reordered in a random fashion to form the ciphertext.

The deciphering operation works in an obviously reverse fashion. The displayed J.M is read as "ciphertext character at position M goes to plaintext position J." Thus in table 8 6.002 would return the B from ciphertext position 2 to the correct plaintext position 6.

Mixed Alphabet Generation

If the optional substitution operation is to be added to the transposition operation, numerical equivalence for each character of the alphabet must be established. In the discussion which followed the Vigenère Tableau method (March 1979 BYTE, page 57, table 3), an ordered alphabet was used in which the numerical values ran, in order, from 0 to one less than the alphabet size (Na−1). In the work which follows, two changes are made. The numerical equivalents are moved

Location	Keys					
01	fLBLA	fCLREG	f P⇆S	STO3	STO4	hR↓
07	STO2	hR↓	STO1	hR↓	STO0	STOA
13	R/S	hCF0	fx<0?	hSF0	hABS	STOC
19	hCF1	fx = 0?	hSF1	fFIX	2	ENT↑
25	2	9	hy^x	STOE	1	STO6
31	fLBL1	5	0	STO5	fLBL5	RCL4
37	fGSBE	STO9	3	0	STO8	÷
43	fINT	STO7	1	9	−	CHS
49	hSTI	RCL8	RCL9	−	RCL8	RCL7
55	×	+	2	h x⇆y	hy^x	STO7
61	RCL(i)	h x⇆y	÷	gFRAC	·	5
67	gx>y?	GTO4	1	STO-5	RCL5	fx ≠ 0?
73	GTO5	fLBL2	RCL3	fGSBE	STO9	1
79	9	hSTI	RCL(i)	STO8	RCLE	STO7
85	fLBL3	RCL8	RCL7	gx>y?	GTO6	STO-8
91	fLBL9	1	RCL7	gx = y?	GTO7	2
97	STO÷7	GTO3	fLBL7	fDSZ	RCL(i)	STO8
103	RCLE	STO7	GTO3	fLBL6	RCL9	fx = 0?
109	GTO8	1	STO-9	GTO9	fLBL4	2
115	STO÷7	fLBL8	RCL7	STO+(i)	2	0
121	hRCI	−·	3	0	×	RCL7
127	fLN	2	fLN	÷	·	1
133	+	fINT	−	EEX	3	÷
139	RCL6	+	STO5	DSP3	R/S	hF?1

Listing 1 continued on page 152.

Entries:

A: A0, A1, A2, Nc
R/S: Na
Na=0 transposition only.
Na≠0 transposition and substitution
+Na encipher
−Na decipher

Registers:

0 Rj
1 A1
2 A2
3 S
4 Nc
5 utility
6 J
7 utility
8 utility
9 R
S0-S9 M-field bit storage
A R_{2j}
B not used
C Na
D not used
E 2^{29}

Listing 1: Crypto program written for the HP 67. This program performs encryption and decryption functions by transposition and substitution as described in the text. The value of Nc must be less than or equal to 300 and the value of Na must not exceed 999. Flag F0 has two states: true for decipher and false for encipher mode. Flag F1 is true when only transposition mode is wanted and false when the dual transposition and substitution mode is used. Flag F2 is used in the random number generation loop.

to the range of 1 to the alphabet size for user convenience only. Secondly, a mixed alphabet is recommended, such as that shown in table 9. This type of alphabet is no harder to use and offers an increase in security over the ordered alphabet.

Generation of such an alphabet is trivial. Columns 1 and 3 are prepared first. Program Crypto is then run in the transposition only mode with a character count equal to the alphabet size. The M values generated are copied into column 2; the J index corresponds to column 3. The data thus formed in columns 1 and 2 permits column 4 to be filled in. Table 9 allows convenient alphabetic-to-numeric conversions (columns 1,2) and numeric-to-alphabetic (columns 3,4).

Dual Mode Operation

Table 10 illustrates the situation in which substitution is done in addition to transposition. Note that a plaintext numerical value row has been added to the plaintext section and a ciphertext numerical value row has been inserted into the ciphertext section. The $\bar{P}j$ row is filled by use of columns 1 and 2 of table 9. Each Crypto cycle now has two parts. In the first part the machine halts with J.M in the display, as before. The user then enters the plaintext ($\bar{P}j$) value (11 for I in this case) from the plaintext value row and depresses R/S. The machine will perform the appropriate addition (modulo Na) and halt showing:

J.M $\bar{C}m$.

For the table 10 example the display would show:

7.002024.

The user then places 24 in position 2 of the ciphertext value ($\bar{C}m$) row and depresses R/S for the next cycle. Columns 3 and 4 of table 9 may be used later to convert the character values to equivalent characters Cm.

In the deciphering operation one starts with the ciphertext and obtains the Cm values from table 9. During the J.M halt in the Crypto cycle the user enters $\bar{C}m$ (24 from position 2 in the 7.002 example) and depresses R/S. The subtraction operation (modulo Na) is performed and the result is shown as:

J.M $\bar{P}j$;

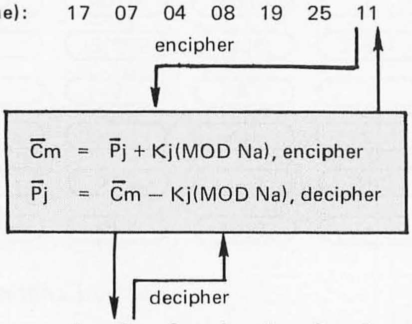
which would be:

7.002011.

This directs that 11 be placed at position 7 of the $\bar{P}j$ row which is thus filled and later converted to character equivalents to complete the deciphering operation.

In actual usage a single index row may serve for both J and M. However, one may wish to record M of the displayed J.M pair as a record of the transposition operations.

J field index:	1	2	3	4	5	6	7	----- j ----- Nc
Pj (plaintext):	S	A	L	E	P	R	I	---
$\bar{P}j$ (plaintext value):	17	07	04	08	19	25	11	



M field index:	1	2	3	4	5	6	7	----- m ----- Nc
$\bar{C}m$ (ciphertext value):	09	24	22	20	17	23	05	-----
Cm (ciphertext):	G	V	M	K	S	D	Z	

Table 10: An example of the dual mode operation of program Crypto, which performs transposition and substitution. To encipher the example shown, the calculator first displays a J.M number. In this case it is 7.002. The user then enters the plaintext value ($\bar{P}j$) or 11. The calculator then displays 7.002024 in the form J.M $\bar{C}m$. This values means that the character which was in the seventh position of the plaintext is moved to the second position of the cipher text and given a value of 24. The value 24 is then given the alphabetic equivalent or V. When deciphering, the calculator again displays a value in the form J.M. Again it will be 7.002. The user then enters the value of the ciphertext ($\bar{C}m$), which is in position 2. This number happens to be 24, the value of the letter V. The calculator then displays a number in the form of J.M $\bar{P}j$, or 7.002011 for the example. This instructs the user to transfer the number that was in position 2 to position 7 and give it a value of 11. This value is converted into the equivalent alphabetic or I.

Either of these processes is repeated for the entire plaintext or codetext until the entire message is decoded or encoded.

Detailed Instructions and Examples

Tables 11 and 12 give detailed instructions for the use of Crypto in the transposition only mode. Tables 13 and 14 give instructions for operation in the dual (transposition and substitution) mode.

These tables contain 10 character examples using the demonstration message and demonstration key. The complete demonstration message processed by transposition only (table 11) using the demonstration key, becomes:

(A: 0.5, 1.625, 3.125, 40 R/S: 0)

E B A E Y   E C N T M
I P D E O   R R Y P P

Text continued on page 150.

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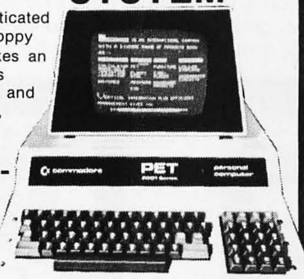


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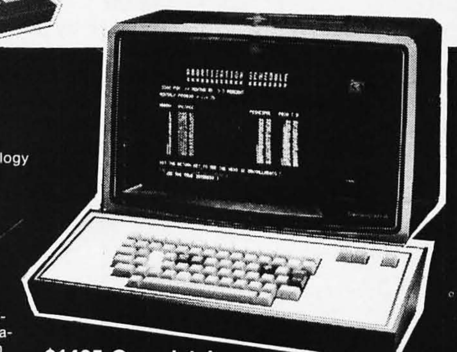


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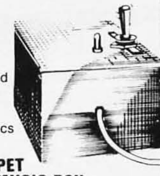
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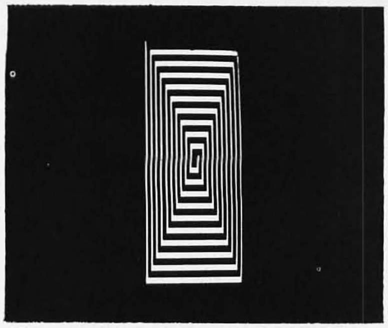
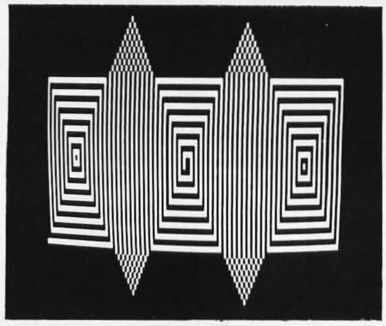
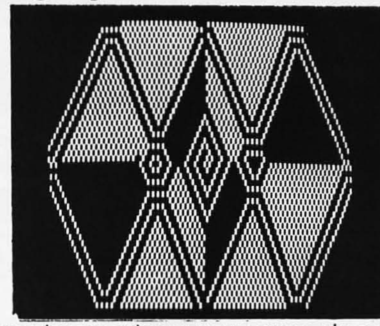
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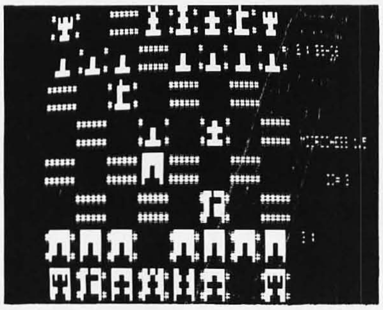
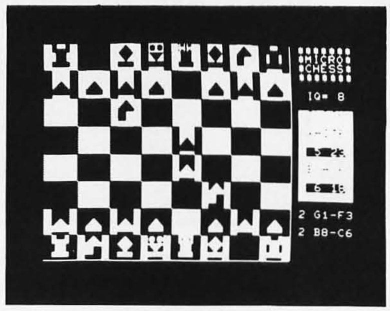
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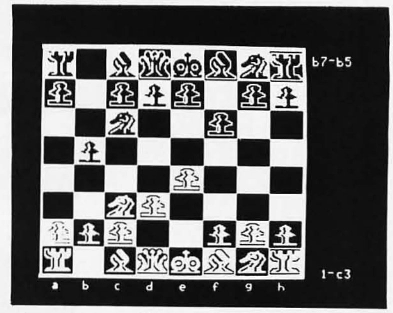
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1. Prepare table as example table 11b shows and enter plaintext Pj. *(11a)*
2. Switch calculator to RUN and ON.
3. Load program.
4. Input data R_0, A_1, A_2, Nc. Follow each entry *except the last* with ENT↑. Press A.
5. Input data 0.
6. Depress R/S to start program.
7. Calculator will stop with a number in the form J.M. Copy plaintext character at position J to ciphertext position M.
8. Depress R/S and return to step 7.
9. Repeat the steps 7 and 8 loop. Pressing R/S after character Nc will cause the ERROR sign to flash. When flashing stops, press R/S one time.
10. If program is to be restarted, return to step 4.

Encipherment Example *(11b)*

J,M	01	02	03	04	05	06	07	08	09	10
Pj	M	A	Y	U	P	B	I	D	P	R
Cm	A	B	M	P	D	I	P	R	U	Y

Table 11: Crypto instructions for enciphering in the transposition only mode. The key is A:0.5, 1.625, 3.125, 10 R/S: 0.

1. Prepare table as example table 12b shows and enter ciphertext Cm. *(12a)*
2. Switch calculator to RUN and ON.
3. Load program.
4. Input data R_0, A_1, A_2, Nc. Follow each entry *except the last* with ENT↑. Press A.
5. Input data 0.
6. Depress R/S to start program.
7. Calculator will stop with a number in the form J.M. Copy ciphertext character at position M to plaintext position J.
8. Depress R/S and return to step 7.
9. Repeat the steps 7 and 8 loop. Pressing R/S after character Nc will cause the ERROR sign to flash. When flashing stops, press R/S one time.
10. If program is to be restarted, return to step 4.

Decipherment Example *(12b)*

J,M	01	02	03	04	05	06	07	08	09	10
Cm	A	B	M	P	D	I	P	R	U	Y
Pj	M	A	Y	U	P	B	I	D	P	R

Table 12: Crypto instructions for deciphering in the transposition only mode. The key is A:0.5, 1.625, 3.125, 10 R/S: 0.

1. Prepare table as example table 13b shows. Enter plaintext Pj and, using alphabet table, enter $\overline{Pj}$ values. *(13a)*
2. Switch calculator to RUN and ON.
3. Load program.
4. Input data R_0, A_1, A_2, Nc. Follow each entry *except the last* with ENT↑. Press A.
5. Input data Na.
6. Press R/S to start program.
7. Calculator will stop with a number in the form J.M. At index J select and enter $\overline{Pj}$ and press R/S.
8. Calculator will stop with a number in the form J.M $\overline{Cm}$. At index M in table enter $\overline{Cm}$ from display.
9. Press R/S and return to step 7.
10. Repeat the steps 7, 8 and 9 loop. Pressing R/S after character Nc flashes the ERROR sign. When flashing stops, press R/S one time.
11. Using alphabet table convert $\overline{Cm}$ to Cm to obtain ciphertext.
12. If program is to be restarted, return to step 4.

Encipherment Example *(13b)*

J,M	01	02	03	04	05	06	07	08	09	10	index.
Pj	M	A	Y	U	P	B	I	D	P	R	plaintext.
$\overline{Pj}$	22	07	10	21	19	02	11	23	19	25	entered at step 7 from alphabet table.
$\overline{Cm}$	13	01	10	22	19	11	05	06	22	09	program output from step 8.
Cm	H	F	Y	M	P	I	Z	X	M	G	from alphabet table.

Table 13: Crypto instructions for enciphering in the dual transposition and substitution mode. The sample table used for enciphering is shown in table 13b. The key is A:0.5, 1.625, 3.125, 10 R/S: 26; table 9 used.

Text continued from page 146:

WEINA CONTC
NNTOU LTTRY.

The same message enciphered in the dual mode (table 13) becomes:

(A: 0.5, 1.625, 3.125, 40 R/S: 26)

SFHIU JIFYY
IMPAI XRVXZ
SAVVW PARTU
SGIWM VFFBG.

In the dual mode operation a conversion operation may be saved at each end of the system by using the numerical $\overline{Cm}$ data directly as the cryptogram. The disadvantage to this is that the number of characters to be transmitted is doubled. In some circumstances transmission of numerals may be preferred over alphabetic characters in spite of the expanded volume.

Use of Nulls

Many procedures may be followed which will aid in protecting the cipher. One of these is the use of nulls. This procedure is very simple to use and actually speeds up the enciphering and deciphering process as discussed in the text box on search strategy. To use this technique, specify a message character length (Nc) to program Crypto which is larger than the actual message length. For example, consider a message of length 100 and an Nc value specification of, say, 125. Crypto is used in the normal way until all 100 message characters are processed into the ciphertext. At this point the 125 character ciphertext contains 25 (scattered) blank spaces. Fill these blank spaces with characters chosen by you at random. When finished, the cryptogram will contain 25 totally irrelevant characters randomly located in the ciphertext.

The nulls present no problem to the decipherer since Crypto will point that person to genuine data for the first 100 processing cycles; after that the nulls are indicated. It might be wise to clearly delineate the end of a message by appending some prearranged terminal symbol to the plaintext. The speed of operation may be greatly increased by use of nulls since this keeps the mean processor time low, as discussed in the text box on search strategy. The longer messages should definitely use nulls to speed up the process. The use of nulls is clearly advantageous, since this presents the cryptanalyst with some additional possibilities that must be sorted out. Make sure that the nulls you supply blend well with the genuine ciphertext. Do not attempt, for example, to bal-



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Listing 1, continued from page 145:

145	GTOfa	ENT↑	1	−	RCLO	RCLC
151	×	fINT	hF?O	GTOfc	+	GTOfd
157	gLBLfc	CHS	RCLC	+	+	gLBLfd
163	RCLC	gx>y?	CLX	−	1	+
169	EEX	6	÷	RCL5	+	DSP6
175	R/S	gLBLfa	1	STO-3	RCL3	h 1/x
181	1	STO+6	6	RCL3	gx>y?	GTO1
187	GTO2	fLBLE	hSF2	RCLA	gLBLfe	RCL1
193	+	RCL2	hy^x	gFRAC	STOA	hF?2
199	GTOfe	×	fINT	RCLO	RCL1	+
205	RCL2	hy^x	gFRAC	STOO	RCLA	−
211	h 1/x	hR↓	hRTN			

Listing 2: Keygen program written for the HP 67. This program generates numerical keys from alphabetic phrases for program Crypto. When using this program, the user needs to know both the key base and the number of the key within the key sequence produced. A detailed description of how to operate program Keygen is given in table 15.

Location			Keys			
1	fLBLD	ENT↑	EEX	1	0	÷
7	fFIX	DSP4	STO6	STO7	STOD	CLX
13	STO9	1	·	2	5	STOA
19	RCL6	EEX	3	×	gFRAC	·
25	7	5	×	+	STOB	RCL6
31	EEX	6	×	gFRAC	3	·
37	7	5	×	RCLA	+	STOC
43	hRTN	fLBLE	STO8	fLBL9	RCL9	RCL8
49	g x>y?	GTO8	RCL6	STO7	STOD	CLX
55	STO9	fLBL8	RCL8	RCL9	−	1
61	−	fx=0?	GTO7	hSTI	fLBL6	gGSBfd
67	fDSZ	GTO6	fLBL7	RCL8	STO9	gGSBfd
73	RCL7	RCL9	+	R/S	RCLE	·
79	7	5	×	RCLA	+	R/S
85	RCLD	3	·	7	5	×
91	RCLA	+	R/S	1	STO+8	GTO9
97	gLBLfd	RCL7	RCLB	+	RCLC	hy^x
103	gFRAC	STO7	RCLD	RCLB	+	RCLC
109	hy^x	gFRAC	STOE	RCLB	+	RCLC
115	hy^x	gFRAC	STOD	RCL7	−	h 1/x
121	hRTN					

ance out the letter frequency count in a transposition only cipher by manipulation of the nulls.

As an example of the use of nulls the following 40 character demonstration message is used with RRXYY appended as end of message indicator. An alphabet length of 60 is chosen, which yields 15 nulls. The cryptogram follows with the nulls underlined:

A: 0.5, 1.625, 3.125, 60
R/S: 0
(*transposition only*)

N B E A R	T L C N L
A O T E M	S P E P I
X R T P N	P O E Y D
W R R R T	O N E C R
Y Y F Y I	U O E N T
G M U I R	T S C N Y

The 15 nulls are distributed randomly throughout the ciphertext. The reader may verify the operation by deciphering this cryptogram. Note that the first null pointed to will be on plaintext character 46, which is the start of the *junk* region.

In addition to the use of nulls, some other precautions may be taken to protect the cipher. The beginning and end of a message can represent sources of vulnerability. Standard or easily guessed salutations and signatures can be of great help to the cryptanalyst. One counter to this is to insert a few nonsense words at the beginning and end of each message using prearranged delineation flags. There is also the *bisection* method, which involves starting the message from some point near the middle, going to the end and then picking up the start. This buries the head and tail of the message somewhere in the middle of the cryptographic process.

The key of program Crypto is the 3 number group (R_0, A_1, A_2). Program Keygen (listing 2) provides for convenient generation of thousands of keys from an easily remembered keyphrase. There is absolutely *no excuse* for using a given key more than once. In dual mode operation use one key for the mixed alphabet transposition table (table 9) and a different key for the Crypto enciphering operation. (By the way, do not be overly impressed by the added complexity of the dual mode cipher. In this business, complexity and security are not necessarily correlated. The transposition only mode represents a very effective cipher in spite of its simplicity of operation. Don't be afraid to use it.)

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CHARACTER GENERATION	5 x 7 character in an 8 x 10 dot matrix
CURSOR	Blinking block

MEMORY

TYPE	Random Access Memory
CAPACITY	2000 characters

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POWER ON/OFF SWITCH	On rear of unit
BRIGHTNESS CONTROL	On rear of unit

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Model 501 — 115 volts, 60 Hz, 100 watts nominal
Model 502 — 230 volts, 50 Hz, 100 watts nominal

INTERFACE

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DATA BITS	7 serial, asynchronous
DATA BIT 8	1, 0 or deleted
PARITY	Odd, even or deleted with error displayed as DLE
STOP BITS	1 or 2
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calculators are compensated for in Crypto by putting the user to work. Because of the manual cooperation required, one quickly learns to keep messages brief. Thus the tendency to keep traffic volume down is, in a lefthanded sort of way, an aid in protecting the cipher.

Program Organization

Extensive use is made of a pseudorandom number generator for producing a sequence Rn where:

$$0 \leqslant R_n < 1. \qquad (4)$$

The algorithm used is:

$$R_{n+1} = \text{FRAC}\,[(R_n + A_1)^{A2}]. \qquad (5)$$

Term (n + 1) of the sequence is obtained from term n by addition of a constant A_1, raising the sum to the power A_2 (another constant parameter), then taking the fractional part of this result as R_{n+1}. The following seed and parameter value ranges have been used successfully:

$$0 \leqslant R_0 < 1 \text{ (seed)}$$

$$1.25 \leqslant A_1 \leqslant 2 \qquad (6)$$

$$1.25 \leqslant A_2 \leqslant 5.$$

Changes in any of these three values by 0.0001 or more will produce rapidly diverging series. At the higher A_2 values much smaller changes in R_0 and A_1 will suffice.

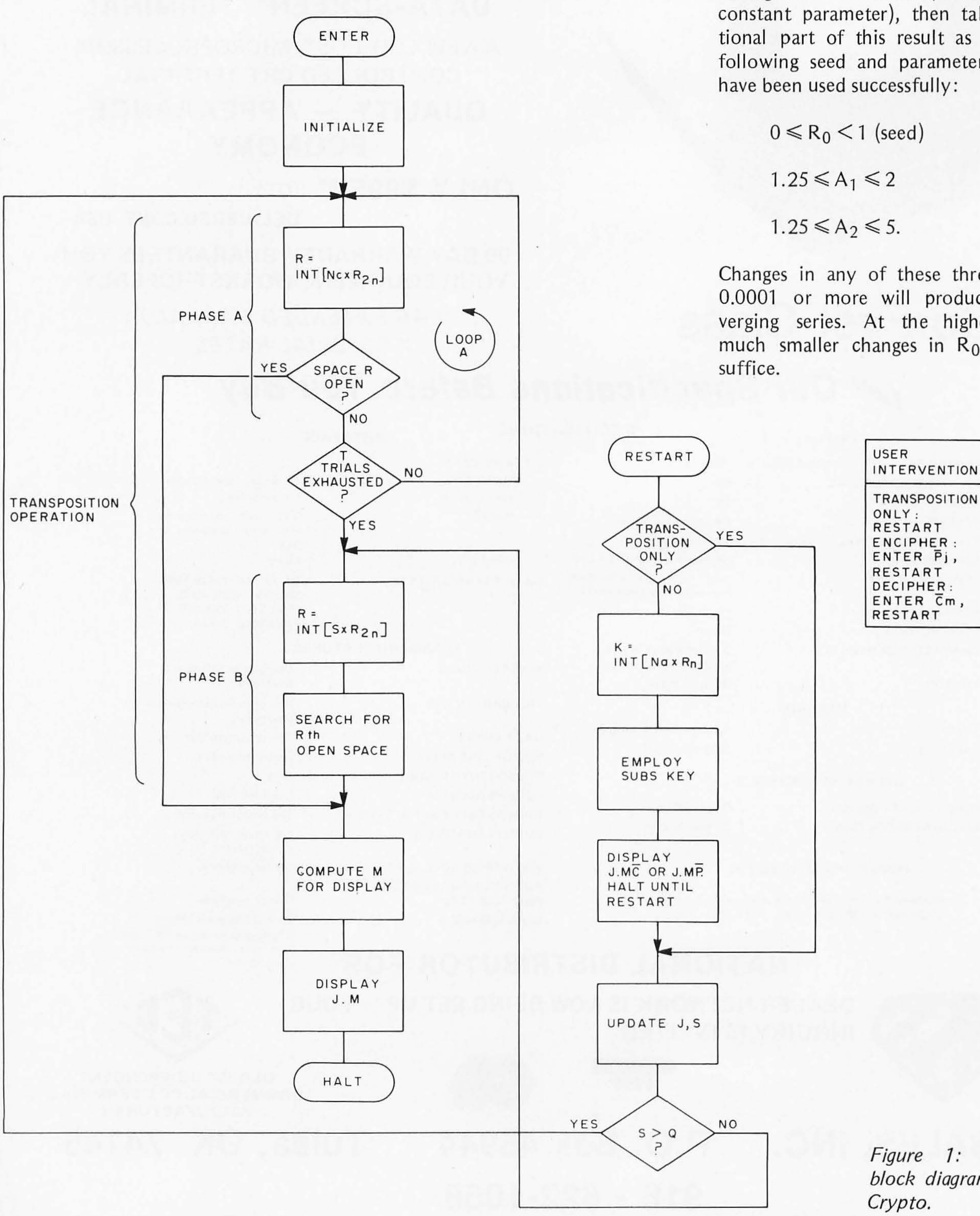
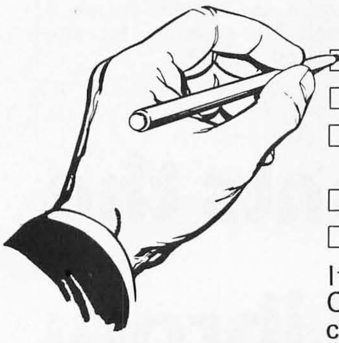


Figure 1: A simplified block diagram of program Crypto.

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DP-II	VTI	Diablo 1610/20	275.
DV-II	VDM	Diablo 1610/20	275.
DR-II	REX	Diablo 1610/20	300.
DI-II	VIO	Diablo 1610/20	300.
NS-II	SOL	NEC Spinwriter	275.
NP-II	VTI	NEC Spinwriter	275.
NV-II	VDM	NEC Spinwriter	275.
NR-II	REX	NEC Spinwriter	300.
NI-II	VIO	NEC Spinwriter	300.
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In place of the old keyphrase PATRICIA ZLOTNIK, three keystream generator numbers (R_0, A_1, A_2) now become the key. The demonstration values are chosen as:

$$(0.5, 1.625, 3.125). \qquad (7)$$

This move from keyphrase to numerical key required by automation is undesirable. A word or phrase is much more easily remembered than a sequence of digits. In order to humanize this process, the program Keygen is written which accepts a keyphrase and produces any number of machine-oriented keys (R_0, A_1, A_2).

The ideal sequence generator would provide an infinite sequence of R_n values, each value being statistically independent of all other values. In practice the sequence must eventually repeat. There is a finite number of digits in the representation of R_n, so there is a finite number of different R_n values that may be produced. Since R_{n+1} is a function only of R_n, once a value is produced that has appeared before, a computational cycle is entered which cannot be broken and a periodic sequence results. This can create serious cryptographic vulnerability problems, especially if the sequence repeats during the processing of a message. Other shortcomings of sequence generators, such as correlation tendencies or biases, can also be exploited by the cryptanalyst.

Protection against looping is provided in Crypto using a technique ascribed by D E Knuth and J Gait to R W Floyd. See especially problem numbers 6 and 7 in Section 3.1 of the Knuth book in the bibliography. Floyd's algorithm requires that a second sequence generator be used, which is cycled twice for every cycle of the first generator. The values of R_n and R_{2n} are compared. As Knuth shows, equality will always be reached before cycling begins. After each cycle of R_n, comparison is made with R_{2n}, and, if equality is detected, Crypto halts (at step 211). If this occurs (very, very unlikely), pick another (R_0, A_1, A_2) key and try again. The author has tested many keys selected at random and found sequence lengths much longer than required for any message, even in the worst cases. The demonstration key (0.5, 1.625, 3.125), for example, has a nonrepeating sequence length which lies between 18,303 and 24,403, after which cycling takes place with a period of 6101.

Transposition Operation

The operating principles of program Crypto can be explained with the aid of

Search Strategy

The method of generation of the random integer R for selection of M-field cells (phase A, figure 1) does not preclude repetition in the random number sequence. That is, on a given pass an M cell can be pointed to that which has already been used. The bits in the special registers are used to represent M-field cells, bit *off* meaning cell open and bit *on* meaning cell already used. Access to and control of these bits currently involves arithmetic rather than logical operations, and processor time becomes an important consideration.

In the phase A portion of figure 1, repeated trials are made to find an open cell. Up to T such trials are permitted before phase B is entered as a slow but sure last resort solution. Timing runs indicate that one phase A trial requires 4.375 seconds of processor time. Hence we define a time cost Ca as:

$$\text{Ca} = 4.375 \text{ seconds}. \qquad (8)$$

This is the time required to test one isolated bit in one of the ten special registers.

In phase B an exhaustive search is made of each bit in the M-field. The overhead is lower here and it takes only 1.533 seconds to search each cell. However, the mean cell number searched until the specified empty cell is found will be roughly half the number of characters in the message (Nc/2). Hence the mean cost of the phase B operation Cb, is:

$$\text{Cb} = 1.533\left(\frac{\text{Nc}}{2}\right) = 0.767 \text{ Nc}. \qquad (9)$$

Note that the phase B cost increases with the number of characters in the message. For long messages, the cost of phase B becomes much greater than the cost of phase A. We seek now a strategy which minimizes the mean overall time cost (Co) for an M cell selection in the transposition table generation. (The substitution operation takes a very short time to complete.)

If the number of open cells is S then the probability of success (Ps) per phase A trial is simply:

$$\text{Ps} = \frac{\text{S}}{\text{Nc}.} \qquad (10)$$

On a given phase A pass, let the first success be on trial K. The probability of this is:

$$(1-\text{Ps})^{\text{K}-1}(\text{Ps});$$

and the total cost of this phase A operation is:

$$(\text{K})(\text{Ca}).$$

The probability that T consecutive failures will occur in phase A (and hence require use of phase B) is:

$$(1-\text{Ps})^{\text{T}}.$$

The cost when this occurs is:

$$(\text{T Ca} + \text{Cb}).$$

Putting these results together, the mean overall cost for a transposition table entry calculation becomes:

$$Co = \sum_{k=1}^{T} (1-Ps)^{K-1}\, Ps\, K\, Ca + (1-Ps)^{T}\, (T\, Ca + Cb). \quad (11)$$

Using the identity:

$$\sum_{N=0}^{K-1} NX^{N} = X\left[\frac{K\,X^{K-1}}{X-1} - \frac{X^{K}-1}{(X-1)^{2}}\right] \quad (12)$$

allows equation 11 to be reduced to:

$$Co = Ca\left[\frac{1-(1-Ps)^{T}}{Ps}\right] + Cb\,(1-Ps)^{T}. \quad (13)$$

The function Co is monotonic in T and behaves as indicated in figure 2. When T is equal to 0, no phase A trials are made and the cost is simply the phase B cost (Cb). As T increases without limit (success in phase A is forced to prevent use of phase B) the mean overall cost has an asymptote of Ca/Ps. If this value is smaller than the cost of phase B (Cb), the lowest mean cost (time) is achieved with the penalty that some calculations may never finish.

As the encipherment (or decipherment) progresses, S becomes smaller and eventually the critical point is reached when the value of the asymptote Ca/Ps equals the cost of phase B (Cb). Using equations (8), (9) and (10), this critical value (Sc) is seen to be:

$$Sc = (Nc)\left(\frac{Ca}{Cb}\right)$$

$$= (Nc)\left(\frac{Ca}{0.767\ Nc}\right) = 5.7; \quad (14)$$

which simply says that when the number of empty cells reaches approximately 6, phase A operation is too expensive (in time) because the probability of success is too low. The strategy at this point is to cut out phase A completely and go directly to phase B. The parameter T controls the exchange of maximum processor time for a transposition table calculation to the mean processor time. Increasing T results in lower mean times and longer maximum times.

Figure 2 shows that, for sufficiently large values of T, the mean time (Co) becomes inversely proportional to the probability of success in phase A (Ps) and hence the number of opens cells (S). One way of keeping the probability of success (Ps) high and the mean cost (Co) low is to pick a number for Nc (message length) which is greater than the actual message length. The program is then used only to process all the legitimate message characters. The remaining spaces are filled with randomly selected characters (nulls). By this artifice, the number of available cells (S) is not permitted to run down to its critical value. Use of this technique is detailed in the main text.

The 2 phase approach of figure 1 has real value even if faster computation is at hand. Random tests of isolated M cells will always be faster than the contiguous M-field search required in phase B. Hence the optimization strategy will always be able to contribute to computational efficiency. Additionally, the pseudorandom nature of the transposition table calculations helps isolate the resulting cryptogram from the keystream generator, hence strengthening the cipher.

Key Generation

Those concerned with field ciphers generally concede that the basic method of operation cannot be kept secret. The security of the cipher, therefore, rests in the key. In some of the examples given in part 1 of figure 1. The ten special registers S0-S9 of the HP 67 are reserved for up to 300 ciphertext character position indicators (M-field). A bit is reset (0) if the corresponding position is open and can accept a ciphertext character. Conversely, the bit is set (1) if that M-field position has been filled in a previous transposition operation.

The transposition operation of figure 1 is comprised of two phases, A and B. Upon entry to phase A the sequence generator is cycled and a random integer number R in the range 0 to Nc − 1 is generated. Position R is then tested in the M-field and if the Rth position is open the bit is set and phase B is bypassed. If the position is already filled, additional tries via loop A are executed. If an open position is not found in T trials, phase B is entered.

Phase B is demanding of processor time, but success here is guaranteed. A count S is kept of the number of open spaces remaining in the M-field. The sequence generator is cycled and random integer number R is generated in the range 0 to S − 1. The entire M-field is then searched and the open positions are counted until the Rth one is reached. When this happens the corresponding bit in the M-field is set and phase B is complete.

Following phases A and B an M value is computed and the transposition pair J.M is displayed with the program halted. The transposition portion of the program is now complete.

Substitution Operation

In dual mode operation the user would at this point enter $\bar{P}j$ (encipher) or $\bar{C}m$ (decipher) and press R/S to restart the program. The necessary residue arithmetic would be done as shown in table 10 and the program would again halt showing either:

J.M $\bar{C}m$ (encipher)

or

J.M $\bar{P}j$ (decipher).

The substitution key is generated from the R_n register of the Floyd algorithm; the sequence generator is not cycled for this operation. In the transposition only mode, this whole process is bypassed as indicated in figure 1.

Throughput Optimization Strategy

After this information is disposed of by the user, the program is restarted. If the number of open spaces in the M-field is Q

this article, the keys were easily remembered keyphrases such as ROYAL NEW ZEALAND NAVY, PHYSICAL EXAMINATION, and our own PATRICIA ZLOTNIK. In program Crypto the key becomes the 3 number group (R_0, A_1, A_2) such as (0.5, 1.625, 3.125).

Since keyphrases are more easily remembered than a sequence of digits, program Keygen has been written to permit the use of keyphrases for the generation of keys for program Crypto. One part of the program key is a 10 digit integer which we may call the key base. Once this base number is entered into Keygen, a number of keys may be generated. Each key triplet is identified by a key number N. If a different key base is used, a different sequence of (R_0, A_1, A_2) keys will be generated. If Keygen is employed, the user needs to know both the key base used to produce the sequence of keys and the number of the key within the sequence.

A convenient way of relating keyphrase to key base is to number the normal alphabet using 2 digit numbers. That is: A = 01, B = 02, C = 03, . . . , X = 24, Y = 25, Z = 26. Now simply associate each letter with the *second digit* of its corresponding numerical value. Ten characters are selected from the keyphrase and their digit-for-character equivalences form the key base. For example, calling once more upon our friend from the main text yields:

P A T R I C I A Z L (keyphrase);
6 1 0 8 9 3 9 1 6 2 (key base).

Using Keygen with this key base, a table of keys may be created and listed by key number N as follows:

N	R_0	A_1	A_2
1	0.6233	1.7175	2.8561
2	0.4283	1.7423	2.6784
3	0.6564	1.7579	3.5444
4	0.3809	1.8209	3.8895
5	0.6771	1.9392	4.8296
6	0.6119	1.9619	3.9956
7	0.7612	1.7418	2.3276
8	0.7039	1.9241	3.4082
9	0.9190	1.7517	2.4218
10	0.9546	1.3436	3.4242

A little imagination in the use of Keygen should make it possible never to have to repeat the use of a key. For example, in a multiple-user environment, each user could be assigned a unique block of key numbers. These would be used in some form of rotation that could be restarted after a new key base is invoked. All users must know the key base by prearrangement. The key number, however, could be contained in the cryptogram. If certain groups are set aside by prearrangement as control groups, the key number information could be contained in these characters.

For example, let the third group of each cryptogram be a control group and assume the same alphabetic-numeric equivalence described in the keyphrase-key base relationship. Let the center character of the third group indicate mode: even number for transposition only, odd number for dual mode. The first two characters of this group could represent mixed alphabet key number for dual mode or would be nulls in the transposition only mode. The last two characters could represent the encipherment operation key number. The control group JNGTI, for example, signals dual mode, indicates key number 4 for mixed alphabet generation, and shows that key number 9 was used in encipherment. The control group is inserted into the cryptogram after encipherment and removed before decipherment.

or less, phase A is skipped and phase B is entered directly. Otherwise the program loops back and enters phase A. This strategy and the choices of T and Q are designed to minimize the mean processing time (details are in the text box on search strategy). Coincidentally this approach presents the cryptanalyst with a highly nonlinear, multivalued barrier from the cryptogram back to the key (R_0, A_1, A_2). On some passes R_n is cycled only once. At the other extreme it is also possible that R_n is cycled T times in phase A and one time in phase B for a total of T + 1 cycles of the R_n generator. The *luck of the draw* nature of the transposition algorithm can produce some dramatic changes in the flow of events arising from very minor situation differences, such as adding or subtracting one character from the plaintext. This algorithm has some interesting trapdoor or one way properties.

General Remarks

With the notable exception of Vernam's onetime key, all cryptographic systems are considered to be vulnerable to cryptanalytic attack. As a consequence any proposed cryptographic technique must be evaluated for degree of security before being used. The adversary roles of the cryptographer and the cryptanalyst have existed for centuries. Mathematical proofs of security (usually based on the impossibility of testing the vast number of combinations offered) have lured innumerable amateurs and a few professionals over the years into positions that later proved embarrassing to the people who formulated the proofs. These proofs of invulnerability were destroyed by competent cryptanalysts who accepted the futility of exhaustive searches and instead searched for other means to break the system. The question of security, which is the very core of cryptography, encompasses many disciplines and occupies the full-time efforts of thousands of talented people worldwide. Part III of the Shannon paper and sections VI and VII of the Diffie and Hellman paper are highly recommended for background in this area (see bibliography).

Standard evaluation methods of secrecy systems involve cryptanalytic attacks on the system. The *ciphertext only* attack is the weakest test, since the analyst is given only ciphertext with which to work. Systems which fail this test are rated as very weak. The *known plaintext* attack allows the analyst access to corresponding portions of plaintext and ciphertext. The most severe test is the *chosen plaintext* attack, in which

Table 15 gives detailed user instructions for program Keygen. An error halt at program location 120 (very unlikely) indicates that a looping condition has been detected in the Keygen random number generator. The largest permissible key number value for this key base is one less than the difference between the contents of register 8 and register I. Either stay within this limitation or change the key base. As a precaution, one could generate the highest numbered key to be used when a new key base is invoked to insure that there are no looping problems within Keygen. As mentioned before, it is very unlikely that this condition will ever be encountered. The 3 sequence generator cycles required by the Floyd algorithm serve double duty in Keygen. For each key triplet generated, the R_n register of Keygen supplies the seed; one less than R_{2n} is used to compute A_1; and R_{2n} is employed in the A_2 calculation.

(14a)

1. Prepare table as example table 14b shows. Enter ciphertext Cm and, using alphabet table, enter $\overline{Cm}$ values.
2. Switch calculator to RUN and ON.
3. Load program.
4. Input data R_0, A_1, A_2, Nc. Follow each entry *except the last* with ENT↑. Press A.
5. Input data Na; follow Na with CHS (that is enter −Na).
6. Press R/S to start program.
7. Calculator will stop with J.M in display. At index M, select $\overline{Cm}$ and enter. Press R/S.
8. Calculator will stop with a number in the form J.M Pj. At index J in table enter $\overline{Pj}$ from display.
9. Press R/S and return to step 7.
10. Repeat the steps 7, 8 and 9 loop. Pressing R/S after character Nc flashes the ERROR sign. When flashing stops press R/S one time.
11. Using alphabet table convert $\overline{Pj}$ to Pj to obtain plaintext.
12. If program is to be restarted, return to step 4.

Decipherment Example *(14b)*

J,M	01	02	03	04	05	06	07	08	09	10	index
Cm	H	F	Y	M	P	I	Z	X	M	G	ciphertext
$\overline{Cm}$	13	01	10	22	19	11	05	06	22	09	from alphabet table. Enter at step 7.
$\overline{Pj}$	22	07	10	21	19	02	11	23	19	25	from program at step 8.
Pj	M	A	Y	U	P	B	I	D	P	R	from alphabet table.

Table 14: Crypto instructions for deciphering in the dual transposition and substitution mode. The sample table used in deciphering is shown in table 14a. The key is A:0.5, 1.625, 3.125, 10 R/S: −26; table 9 used.

1. Set calculator switches to RUN and ON.
2. Load program.
3. Enter the 10 digit integer key base number and press D.
4. Enter key number N desired and press E.
5. Display will show a number in the form N.R_0 with four digits assigned to R_0. Key number N is shown for identification only.
6. Press R/S to obtain A_1.
7. Press R/S to obtain A_2. This completes key number N data (R_0, A_1, A_2).
8. If R/S is pressed at this point, the program cycles back to step 5 with N+1 replacing N. Thus, the 5,6,7,8 loop may be used to obtain a sequence of keys.
9. After step 7, the user may start a new sequence by returning to step 4. To save time, plan use so that N values are called for in ascending order.
10. Step 3 may be entered after step 7 to change the key base.

Table 15: Detailed instructions for using program Keygen to generate keys which are used with program Crypto.

the analyst chooses the plaintext source material and the corresponding ciphertext is also made available for analysis.

With the above in mind, the trapdoor systems described earlier display yet another fascinating difference from the classical cryptographic techniques. Normally the material for plaintext attacks must be obtained through devious means. In the trapdoor case the public encryption key invites chosen plaintext attack at the leisure of the analyst. If the system is strong enough to survive this test, it is strong indeed by classical standards. The revival of the *large number of possibilities* argument which has been discredited so many times in the past is also most curious. Can it be that the trapdoor approach results in a situation in which large numbers are both necessary *and sufficient*? Consider this remarkable statement by Martin Gardner:

> *Computers and complexity theory are pushing cryptography into an exciting phase, and one that may be tinged with sadness. All over the world there are clever men and women, some of them geniuses, who have devoted their lives to the mastery of modern cryptanalysis. Since World War II even those government and military ciphers that are not one-time pads have become so difficult to break that the talents of these experts have gradually become less useful. Now these people are standing on trapdoors that are about to spring open and drop them completely from sight.*

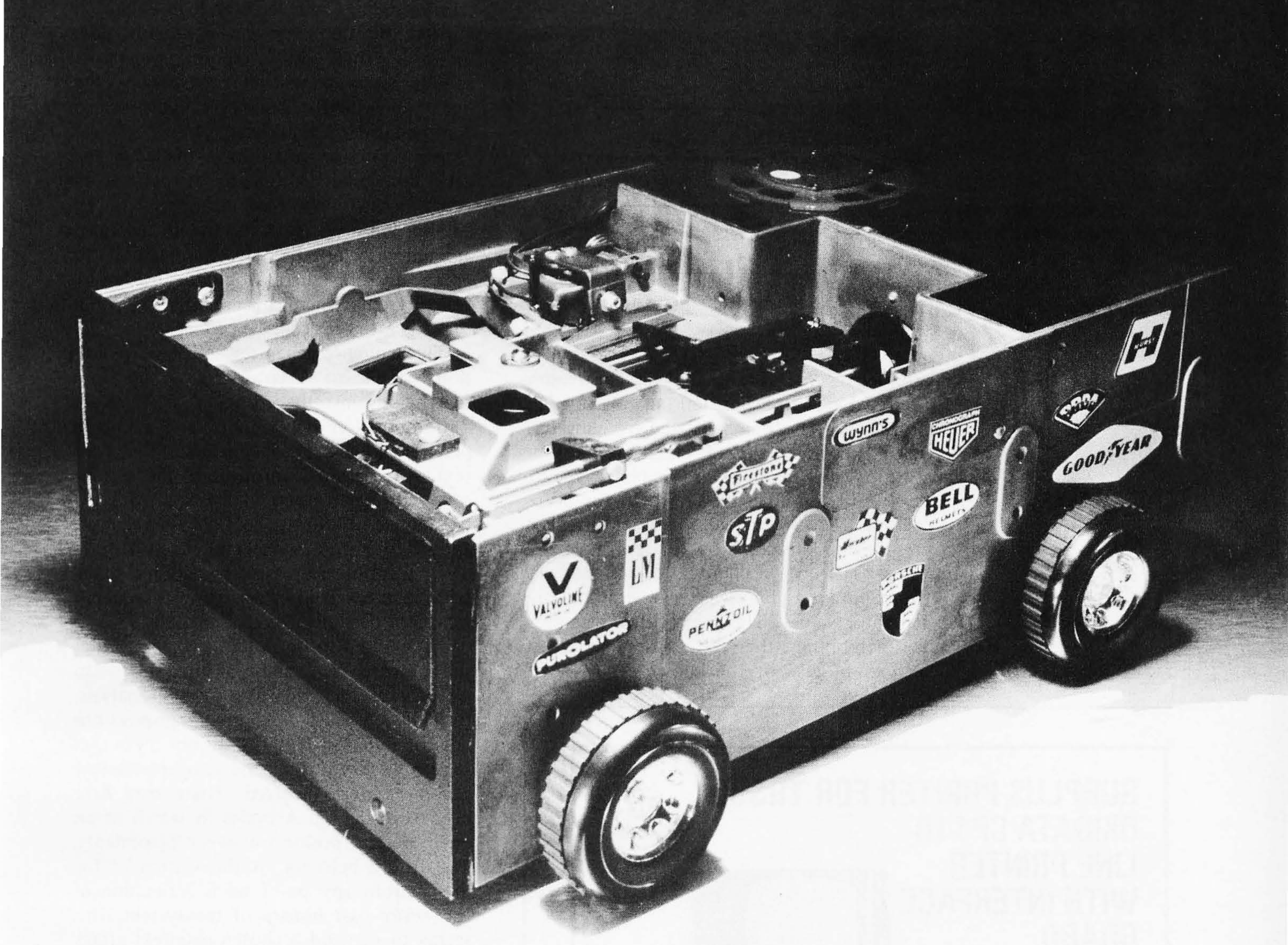
This statement, cited in the bibliography, is made all the more remarkable when one considers the stature of the man who made it. Aside from the trapdoor hypothesis, there is the indication here that emerging technology has been favoring the cryptographer and that the cryptanalyst is being outdistanced in this phase of the race. Advances in computer technology may have given governments the privacy they seek for their communications. Will further advances extend this same privilege to the common citizen?

Progress in communication techniques, data processing and data storage has made it increasingly convenient for governments to invade the privacy of their citizens. Further developments in cryptographic theory and related digital processing devices are bound to lower costs considerably. The step from insuring the privacy of computer based business transactions to insuring the privacy of personal communications and records is not too hard to imagine. Science knows no politics or philosophy. Technology, which in the past has permitted established groups to invade the privacy of the individual, may be about to make restitution.

Evaluation of Crypto

In the qualitative discussion which follows, a known plaintext attack will be

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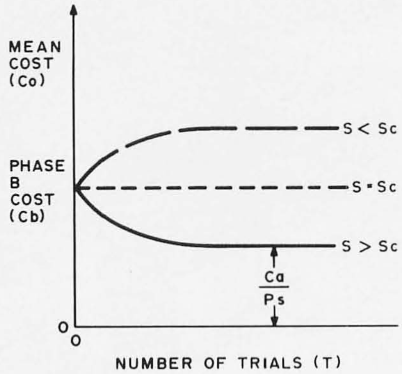


Figure 2: Graph showing the variation in the mean cost with respect to the number of trials allowed to take place to find an empty cell.

assumed as the testing vehicle. The reason for making transposition mandatory in Crypto may be demonstrated by considering a known plaintext attack on a substitution cipher. In such a cipher, character positions remain unaltered in the cryptogram. The ciphertext character values are the modulo sums of key and plaintext values. The known plaintext attack removes the plaintext value cover to reveal the key generator values. The analyst then attempts to determine the generator parameter settings by use of the known sequence of generator key numbers. In a straight substitution cipher the security load is carried entirely by the keystream generator. Gait indicates that shift register generators produce very poor ciphers, especially the linear congruential generators which are in common use (see bibliography).

No claim for greatness is made for the generator used in Crypto as defined in equation (5). We have ignored Knuth's admonition not to select a random generator at random. While this algorithm appears to be satisfactory, there would be no hesitation in replacement by a better algorithm that fits into the available coding space.

The sequence generator and the organizational logic of Crypto (figure 1) work together against the cryptanalyst. Consider a transposition only cipher and a known plaintext attack. The characters of the plaintext are scattered throughout the ciphertext with replications. There are 13 Ts in the sample of known plaintext, for example, and 48 Ts in the cryptogram. There are too many ways to relate these two groups (plaintext-ciphertext) in order to get sequence generator output strings for analysis.

It should also be noted in figure 1 that that the phase A/phase B logic plays an important role in frustrating analysis. Even if consecutive plaintext transpositions could be identified, this does not mean that sequential outputs of the random number generator were involved. There may have been several loop A cycles in search of an open M field position between placements. The future behavior of the system of figure 1 from any point on is a *function of* the *entire past history* of the system. This seems to demand a chosen plaintext attack based on the beginning of the message. The analyst cannot jump into the middle of the process, so to speak. In fact, even if the entire transposition sequence (M_1, M_2, . . . , M_{Nc}) were known, there does not appear to be a sure way of working back to the (R_0, A_1, A_2) generating key. The quantizing operation INT [Nc X R_{2n}] defines only a range for R_{2n} when the result is given, and represents a complicating factor. The *lost* odd cycle of the sequence generator in the transposition operation should also prove quite annoying to the analyst. The Floyd algorithm is thus used to protect the cipher in two ways.

Further protection may be obtained from the substitution operation. If the alphabet is expanded to include numerals, the scrambled order of numerals in the transposition only cryptogram may still be too revealing. In such cases the dual mode of operation is highly recommended. I believe that a very effective cryptographic

capability results if Crypto is used according to the instructions given.

The author wishes to express his thanks to Dr J C Buchta and Dr S B Akers, Jr, both of the General Electric Company, for many interesting comments and criticisms.

I O E O L	A O M N A
	F G P T H
F I I E R	T O O O E
M U S E X	H H X A R
H S L N T	S R R D H
A D O T Y	R S R F N
A F T E H	T K E B A
O O E A O	G S H U T
R W X W I	F I K M R
F W R G O	P D N U D
T I Y R T	B O Y U L
S E G O R	

BIBLIOGRAPHY

1. Kahn, David, *The Codebreakers, the Story of Secret Writing*, Macmillan, New York, 1967.

2. Vernam, G S, "Cipher Printing Telegraph Systems for Secret Wire and Radio Telegraphic Communications," *Journal of the American Institute of Electrical Engineers*, volume 45, pages 109 thru 115, 1926.

3. Shannon, C E, "Communication Theory of Secrecy Systems," *Bell System Technical Journal*, volume 28, October 1949, pages 656 thru 715.

4. Diffie, W and Hellman, M E, "New Directions in Cryptography," *IEEE Transactions on Information Theory*, volume IT-22, number 6, November 1976, pages 644 thru 654.

5. Knuth, D E, *The Art of Computer Programming, volume 2, Seminumerical Algorithms*, Addison-Wesley, Reading MA, 1969.

6. Rivest, R L, Shamir, A and Adleman, L, "A Method for Obtaining Digital Signatures and Public Key Cryptosystems," *Communications of the ACM*, volume 21, number 2, February 1978, pages 120 thru 126 and 179.

7. Gait, J, "A New Nonlinear Pseudorandom Number Generator," IEEE Transactions on Software Engineering, volume SE-3, number 5, September 1977, pages 359 thru 363.

8. Gardner, Martin, "Mathematical Games/A New Kind of Cipher That Would Take Millions of Years to Break," *Scientific American*, August 1977, pages 120 thru 124.

9. Gaines, Helen F, *Cryptanalysis, A Study of Ciphers and Their Solutions*, Dover, New York, 1956. (Formerly published under the title, *Elementary Cryptanalysis*.) ■

Life Can Be Easy

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I've written a fairly short and simple program (about 220 bytes) to play Life on an 8080 based system. You need only two pages of memory for the program and the playing board. When this was originally written, I had only 1 K bytes of memory in my Altair, so this version is a simple one. A few extensions are suggested, but they are not necessary to enjoy Life.

The playing board is a 16 by 16 grid taking one page (256 bytes) of memory. Only the two least significant bits of each byte are used, and the leftmost column and top row are used as a border. If you don't use the border, the top of the board is next to the bottom, and the right edge is next to the left edge.

The board is arranged as shown in figure 1. The number in each box is its address in memory. It is initialized by first setting all locations to 00. Next, hexadecimal locations 00 through 0F (the top row) and 10, 20, 30 . . . E0, F0 (left column) are set to hexadecimal FF. Each cell with FF is a border cell and is ignored by the rest of the program. The function of the border will become clear later.

The initial pattern must be loaded by some other loader program or through your front panel. You simply draw the first generation on a sheet of graph paper numbered as in figure 1, then set the address of each line cell to hexadecimal 01.

Each byte looks like figure 2. Note that only the two least significant bits of each byte are used. Bit zero is a 1 if that cell is alive this generation. If it will be alive next generation, bit one is also a 1. To make the next generation into this generation, we need only shift each memory location to the right.

The program is written to be simple — not efficient or fast — and consists of six main routines that are called repeatedly for each cell (see listing 1). Subroutine NCOUNT, for example, is called about 1,900 times each generation.

The first routine, BDINIT, initializes the board (clears it and sets up border) and then jumps to your loader to get the initial pattern. After you have loaded an initial pattern, you will want to write it out on your terminal before the next generation is computed. This is done by routine WRITE. The border characters are written as a slash and the live cells as a star.

Before a line is written, it is scanned for live characters. If none are alive, a slash and a carriage return are output, and the next line is checked. This saves the computer the task of writing a line of blanks and can save considerable time in writing out small patterns.

Now we have the board set up and the initial pattern loaded and checked. The computer is ready to calculate the next generation. Since the status of a cell (alive or dead next generation) depends only on the number of live neighbors, the program simply goes from one cell to the next counting the number of live neigh-

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
20															2F
30															3F
40															4F
50					55	56	57	58	59	5A	5B				5F
60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
80					85	86	87	88	89	8A	8B				8F
90															9F
A0															AF
B0															BF
C0															CF
D0	D1	D2													DF
E0	E1	E2	E3	E4											EF
F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF

Figure 1: Layout of the Life board in memory. The number of each box is its address. The shaded boxes are border cells.

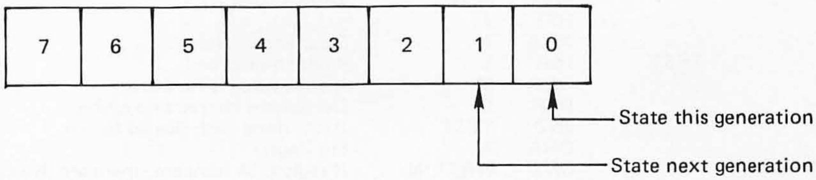


Figure 2: Bit zero is the present generation bit. Bit one is the next generation bit. The rest of the word is not used.

bors. For example, if we are looking at the cell at location hexadecimal 68, we would check cells 57 thru 59, 67, 69 and 77 thru 79. This is done by subroutine VALCK. When the routine is exited, register E holds the number of live neighboring cells.

Next subroutine ESET is called. This routine sets the next generation bit if register E equals 3, clears it if register E equals 0, 1, 4, 5, 6, 7, or 8 and sets it equal to the present generation if register E equals 2. The only variation from this procedure concerns the border cells. They are treated as dead cells when counting neighbors. If we are pointing to a border cell when VALCK is called, the routine is exited before any tests are performed. To initialize the board, begin at BDINIT. After you have loaded the first generation, enter at WRITE, and your work is done.

Listing 1: The board initialization routine (BDINIT) sets the entire board (figure 1) to 00. Next the border cells are set to FF. A jump is then made to the loader program to get the initial pattern. Subroutine WRITE displays the board on the video display. Border characters are written as a slash, live cells as a star. If your display doesn't scroll on a carriage return, you will have to change this routine. The next generation is calculated by subroutine MOVE by calling VALCK and ESET for each cell. After MOVE is done, routine UPDATE is entered and the board is output. Update rotates each nonborder cell to the right. The next generation bit moves into the present generation bit. VALCK is called by the main MOVE routine. MOVE sets register pair BC to the address of the current cell. The HL registers look at its neighbors. NCOUNT checks the cell addressed by register pair HL. If that cell is alive, register E is incremented. This routine is called repeatedly by VALCK which sets up the HL register pair before calling. ESET sets the next generation bit based on the contents of register E. ESET is called after VALCK and determines the number of live neighbors.

Hexadecimal Address	Hexadecimal Code			Label	Op Code	Operand	Comment
0A00	06	00		BDINIT	MVI	B,00	This part sets
0A02	68				MOV	L,B	every byte of page
0A03	26	09			MVI	H,09	08 to 00.
0A05	70			CLEAR	MOV	M,B	
0A06	2C				INR	L	
0A07	C2	05	0A		JNZ	CLEAR	
0A0A	3E	11			MVI	A,11	This section
0A0C	06	FF			MVI	B,FF	sets the top
0A0E	2E	00			MVI	L,00	row (address 00
0A10	70			TOPROW	MOV	M,B	thru hexadecimal 10)
0A11	2C				INR	L	to hexadecimal FF.
0A12	BD				CPR	L	
0A13	C2	10	0A		JNZ	TOPROW	
0A16	2D				DCR	L	L = 10.
0A17	AF				XRA	A	
0A18	57				MOV	D,A	
0A19	1E	10			MVI	E,10	Number of cells per row.
0A1B	70			EDGE	MOV	M,B	Add 10, move pointer down one row.
0A1C	19				DAD	D	
0A1D	BD				CPR	L	
0A1E	C2	1B	0A		JNZ	EDGE	Done when L = 00.
0A21	C7				RST	0	Jump to loader.
0A22	21	00	09	WRITE	LXI	H,00 09	Start of board.
0A25	0E	0F		BWRITE	MVI	C,0F	Number of characters per line.
0A27	5D				MOV	E,L	Save starting address of this line.
0A28	AF				XRA	A	Write a carriage return.

Listing 1 continued on next page.

Listing 1, continued:

```
0A29  FF               RST   7         Output routine.
0A2A  00               NOP
0A2B  00               NOP
0A2C  00               NOP
0A2D  3E  2F           MVI   A,2F      Write a slash (/).
0A2F  FF               RST   7
0A30  AF               XRA   A         Clear accumulator.
0A31  2C       TEST    INR   L         Point to next cell.
0A32  B6               ORA   M         If alive value is nonzero.
0A33  0D               DCR   C         Decrement character counter.
0A34  C2  31 0A        JNZ   TEST      If not done with live go to test.
0A37  B7               ORA   A         Set flags.
0A38  C4  42 0A        CNZ   WRTLIN    If register A nonzero, there are live cells.
0A3B  2C               INR   L
0A3C  CA  65 0A        JZ    MOVE      Compute next move if done writing board.
0A3F  C3  25 0A        JMP   BWRITE
0A42  6B       WRTLIN  MOV   L,E       Address of start of line.
0A43  0E  0F           MVI   C,0F      Restore character counter.
0A45  2C       NEXT    INR   L         Point to first nonborder cell.
0A46  7E               MOV   A,M
0A47  FE  01           CPI   01
0A49  CA  57 0A        JZ    ALIVE     Jump if cell is alive.
0A4C  FE  FF           CPI   FF
0A4E  CA  5D 0A        JZ    SLASH     Jump if border cell.
0A51  3E  20           MVI   A,""      Must be dead cell.
0A53  FF               RST   7         Write dead cell.
0A54  C3  60 0A        JMP   OVER
0A57  3E  2A   ALIVE   MVI   A,"*"     Living cell.
0A59  FF               RST   7
0A5A  C3  60 0A        JMP   OVER
0A5D  3E  2F   SLASH   MVI   A,"/"     Dead cell or border.
0A5F  FF               RST   7
0A60  0D       OVER    DCR   C         Decrement character counter.
0A61  C2  45 0A        JNZ   NEXT      Jump if not done wlth line.
0A64  C9               RET
0A65  0E  11   MOVE    MVI   C,11      Address of first nonborder cell.
0A67  26  09           MVI   H,09      Page of board.
0A69  44               MOV   B,H       Page of board.
0A6A  CD  8A 0A NXCELL CAL   VALCK     E returns number of living neighbors.
0A6D  CD  BD 0A        CAL   ESET      Set next generation bit of current cell.
0A70  0C               INR   C         Point to next cell.
0A71  CA  77 0A        JZ    UPDATE    Go to update routine if done with board.
0A74  C3  6A 0A        JMP   NXCELL    If not done go to next cell.
0A77  2E  0A   UPDATE  MVI   L,0A      First nonborder cell.
0A79  7E       LOOP    MOV   A,M       Get cell from memory.
0A7A  FE  FF           CPI   FF        Border cell?
0A7C  CA  83 0A        JZ    BRDR      Then don't rotate.
0A7F  1F               RAR             Rotate next generation into this generation.
0A80  E6  01           ANI   01        Clear unused bits.
0A82  77               MOV   M,A       Put it back.
0A83  2C       BRDR    INR   L         Point to next cell.
0A84  C2  79 0A        JNZ   LOOP      Do next cell.
0A87  C3  22 0A        JMP   WRITE
0A8A  1E  00   VALCK   MVI   E,00      E counts number of living around cell.
0A8C  0A               LDAX  B         Get current cell.
0A8D  FE  FF           CPI   FF        Is this a border?
0A8F  C8               RZ              Skip all tests.
0A90  79               MOV   A,C       Put address of cell in accumulator.
0A91  D6  11           SUI   11        Address of cell above and left of current cell.
0A93  6F               MOV   L,A       Put new address in register L.
0A94  CD  B5 0A        CAL   NCOUNT    Test it.
0A97  2C               INR   L         Point to neighbor above current cell.
0A98  CD  B5 0A        CAL   NCOUNT    Test it.
0A9B  2C               INR   L         Neighbor above and right of current cell.
0A9C  CD  B5 0A        CAL   NCOUNT    Test it.
0A9F  69               MOV   L,C       Cell to the left of current cell.
0AA0  2D               DCR   L
0AA1  CD  B5 0A        CAL   NCOUNT    Test it.
0AA4  2C               INR   L         Cell to right of current cell.
0AA5  2C               INR   L
0AA6  CD  B5 0A        CAL   NCOUNT    Test it.
0AA9  79               MOV   A,C       Cell below and left of current cell.
0AAA  C6  0F           ADI   0F
0AAC  6F               MOV   L,A
0AAD  CD  B5 0A        CAL   NCOUNT    Test it.
0ABD  2C               INR   L         Cell below current cell.
0AB1  CD  B5 0A        CAL   NCOUNT    Test it.
0AB4  2C               INR   L         Cell below and right of current cell.
0AB5  7E       NCOUNT  MOV   A,M       Get cell from memory.
0AB6  FE  FF           CPI   FF        Border cell?
0AB8  C8               RZ              Return if so.
0AB9  1F               RAR             Rotate low bit into carry.
0ABA  D0               RNC             Return if dead cell.
0ABB  1C               INR   E         Count if alive.
0ABC  C9               RET
```

```
0ABD  0A          ESET    LDAX B      Get current cell addressed by BC.
0ABE  FE  FF              CPI  FF     Border cell?
0AC0  C8                  RZ          Return if border.
0AC1  E6  01              ANI  01     Clear next generation bit.
0AC3  1D                  DCR  E
0AC4  1D                  DCR  E
0AC5  CA  D2 0A           JZ   SRVIVE If register E is 2 cell will survive.
0AC8  1D                  DCR  E
0AC9  CA  CE 0A           JZ   ALIVE  If register E is 3 cell is alive next generation.
0ACC  02                  STAX B      Cell is dead next generation.
0ACD  C9                  RET
0ACE  F6  02      ALIVE   ORI  02     Set next generation bit.
0AD0  02                  STAX B      Put back in memory.
0AD1  C9                  RET
0AD2  FE  00      SRVIVE  CPI  00     Cell dead now?
0AD4  02                  STAX B
0AD5  C8                  RZ          If dead, return.
0AD6  F6  02              ORI  02     If alive now, set next generation bit and put back in memory.
0AD8  02                  STAX B
0AD9  C9                  RET
```

Possible Improvements

In this program the time needed to compute the next generation is insignificant compared to the time needed to write out and observe the pattern. I feel that any effort to speed up execution just isn't worth the trouble.

The first routine you should add would be a better way to load the initial pattern. If you have cursor control (up-down, right-left), it should be easy to add a fast, easy loader. A 16 by 16 grid is small for doing any serious experimenting on. Many interesting patterns run into the border; or if you don't use the border, the left edge interferes with the right and top interferes with bottom. You will have to use the dual addition instructions and complement arithmetic in VALCK, because adjacent cells won't always be on the same page.

I am interested in hearing about any improvements to this program or about any interesting patterns you may discover. Have fun!■

An Easy Way to Calculate Sines and Cosines

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The instruction set of a typical 8 bit processor can be quite confining at times. Any task requiring more than simple integer addition and subtraction can become a nuisance. There are reference books from which multiplication and division routines can be obtained, and square root and other functions can be built by using expansion, iteration, or other well-known methods. Implementing these algorithms on a microprocessor uses much space and programming time. Trigonometric functions are among this class of difficult functions. However, if one can tolerate accuracy of one part in 100, and allow about 1 ms per computation, the routine described in this article will provide sine and cosine values in a very simple 40 byte routine. I have coded it for a Motorola M6800 processor but it could easily be converted to any other processor.

Location	Op Code	Operand	Label	Assembly Code
			* SUBROUTINE TO COMPUTE SINE AND COSINE	
			* AS SINGLE-BYTE INTEGERS (SIGNED)	
			* STEP SIZE OF 1/16 RADIAN, OR 3.58 DEGREES	
			* ACCURACY OF ABOUT 1% FOR RANGE 0 THROUGH 90 DEGREES	
			*	
0000			THETA	RMB 1 *ARGUMENT TO FUNCTION
0001			SINE	RMB 1 *SINE OF THETA
0002			COSINE	RMB 1 *COSINE OF THETA
0003	86	7E	START	LDA A #126 *BEGIN INITIALIZATION
0005	B7	0002		STA A COSINE
0008	7F	0001		CLR SINE
000B	B6	0000		LDA A THETA
000E	F6	0002		LDA B COSINE *COMPUTE NEW SINE
0011	57		CYCLE	ASR B
0012	57			ASR B
0013	57			ASR B
0014	57			ASR B
0015	FB	0001		ADD B SINE
0018	F7	0001		STA B SINE
001B	57			ASR B *COMPUTE NEW COSINE
001C	57			ASR B
001D	57			ASR B
001E	57			ASR B
001F	F0	0002		SUB B COSINE
0022	50			NEG B
0023	F7	0002		STA B COSINE
0026	4A			DEC A
0027	2C	E8		BGE CYCLE *LOOP UNTIL DONE
0029	39			RTS

Listing 1: 6800 routine for computing sines and cosines over the range 0 to π/2 radians (0 to 90 degrees).

Theory

The algorithm is based on two trigonometric identities:

$$\text{sine}(\theta+s) = \sin(\theta)\cos(s) + \cos(\theta)\sin(s)$$
$$\cos(\theta+s) = \cos(\theta)\cos(s) - \sin(\theta)\sin(s)$$

where θ is the angle we are interested in and s is a small step in angle added to θ. If we make the step small enough, we can approximate sin(s) and cos(s) as follows:

$$\sin(s) = s$$
$$\cos(s) = 1$$

Combining these four equations we get:

$$\sin(\theta+s) = \sin(\theta) + s\cos(\theta)$$
$$\cos(\theta+s) = \cos(\theta) - s\sin(\theta)$$

Solving for sine and substituting into the cosine formula:

$$\cos(\theta+s) = (1+s^2)\cos(\theta) - s\sin(\theta+s)$$

Since s is very small, we can neglect s^2 and write:

$$\cos(\theta+s) = \cos(\theta) - s\sin(\theta+s)$$

Given that we have values for $\sin(\theta)$ and $\cos(\theta)$ at some point, we can get to any other angle by stepping through the two approximations, first computing $\sin(\theta+s)$ and then using that to compute $\cos(\theta+s)$. We choose to start at θ equal to zero, and set $\cos(\theta)$ to the largest positive value that can

be stored as a signed byte without causing overflow when negated and decremented. Hence cos(0) = 126. Similarly the sin(0) = 0. The step size is chosen to be 0.0625 radian or about 3.58°. The step size must be a binary fraction so that all the multiplication involved in the equations can be performed by arithmetic shifts. If more accuracy is needed, the step size is easily reduced by introducing more shifts into the algorithm.

Program

The assembly code program for the Motorola 6800 version of the routine is shown in listing 1. When called with the angle stored in variable THETA, it returns the sine and cosine of that angle. The accuracy is quite good for angles less than $\pi/2$ radians (90 degrees). For angles larger than $\pi/2$ radians, other trigonometric identities can be used:

$$\sin(\theta) = \cos(\pi/2-\theta) = \sin(\pi-\theta)$$
$$\cos(\theta) = \sin(\pi/2-\theta) = (-\cos(\pi-\theta))$$

Thus, the sine and cosine of any angle can be computed from the values over the range 0 to $\pi/2$ radians. These identities can be coded quite easily.

All the other trigonometric functions can be computed from the values of sine and cosine. All that is needed is an integer division routine such as the following:

$$\text{cosec}(\theta) = 126/\sin(\theta)$$
$$\sec(\theta) = 126/\cos(\theta)$$
$$\tan(\theta) = \sin(\theta)/\cos(\theta)$$
$$\cot(\theta) = \cos(\theta)/\sin(\theta)$$

Be careful of overflows and division by zero problems.

This algorithm can perform other tricks. It can generate continuous sine waves of any desired amplitude, period, or phase. Coupled with a digital to analog converter, it could form part of a modem or synthesizer. It could simulate mixers, AM or FM modulators, keyers, etc.

The maximum frequency it can generate depends on the processor cycle time. A 6800 processor running with a 1 MHz clock could generate a 200 Hz sine wave since there are about 50 machine cycles per step, and about 100 steps per wave. Increasing the step size to 0.125 radians would increase the maximum frequency to about 500 Hz. A step size of 0.25 radians would yield a maximum frequency of nearly 1050 Hz.

I hope that this algorithm will help programmers solve problems involving trigonometric functions, and that applications for microcomputers will expand into new areas where these functions are useful.■

Desk Top Wonders

Digital Circuit Simulation

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Listing 1: TI-59 calculator program for the digital circuit simulator.

```
76 LBL
38 SIN
86 STF
00 00
61 GTO
33 X²
00 0
76 LBL
35 1/X
71 SBR
40 IND
09 09
43 RCL
30 30
55 ÷
01 1
00 0
95 =
92 RTN
68 NOP
43 RCL
29 29
49 PRD
30 30
92 RTN
68 NOP
68 NOP
68 NOP
68 NOP
68 NOP
43 RCL
29 29
67, EQ
00 00
37 37
42 STO
30 30
92 RTN
68 NOP
68 NOP
71 SBR
00 00
20 20
71 SBR
00 00
60 60
92 RTN
68 NOP
68 NOP
68 NOP
71 SBR
00 00
30 30
71 SBR
00 00
60 60
92 RTN
68 NOP
68 NOP
68 NOP
01 1
94 +/-
49 PRD
30 30
01 1
44 SUM
30 30
92 RTN
68 NOP
68 NOP
43 RCL
29 29
75 -
43 RCL
30 30
95 =
33 X²
42 STO
30 30
92 RTN
73 RC*
10 10
22 INV
59 INT
85 +
43 RCL
30 30
85 +
43 RCL
29 29
75 -
93 .
01 1
95 =
22 INV
67 EQ
01 01
01 01
01 1
42 STO
30 30
92 RTN
68 NOP
68 NOP
76 LBL
15 E
03 3
00 0
32 X:T
00 0
32 X:T
42 STO
10 10
01 1
63 EX*
10 10
76 LBL
28 LOG
63 EX*
```

Listing 1 continued on opposite page.

The program in listing 1 was developed for a TI-59 calculator to allow simulation or testing of combinational logic circuits. The circuit elements allowed and their identification numbers are:

Number	Type
20	AND
30	OR
40	NAND
50	NOR
60	NOT
70	XOR
80	SR latch

Registers 11 through 25 are used to store the input values to the circuit. The circuit elements themselves are stored in registers 31 through 99. A code word is stored in each register that defines its inputs and its function. The format used is:

XXYYZZ.V,

where:

XX = Input Device 1
YY = Input Device 2
ZZ = Device Identification Number
V = Output of this device (0 or 1).

Note that the complete code must be entered for each device. Therefore, for the NOT device the same input number is entered for both XX and YY.

The minus sign is used as a code to indicate that a device has been asserted. At the start of each run the machine automatically sets all registers to a positive value. After the run is completed, each register should have a minus sign. The output value is given by the first digit to the right of the decimal point.

The circuit itself is set up on the machine by storing the appropriate values in registers 31 and greater. Devices are assigned registers consecutively starting with 31, in any order desired. However, the program runs faster with consecutive assignments. A 0 stored in a register tells the calculator that all devices have been processed. Therefore, you must be certain that no register numbers are skipped and that the last valid register is followed with a register containing 0.

The input values are stored into registers 11 through 25 by the following coding:

logical 0	store − 1.0
logical 1	store − 1.1

An alternate, and more convenient, method is available for registers 11 through 18. Just enter the logical value, 0 or 1, and press one of the keys A to D or A' to D' in accordance with the following assignment table:

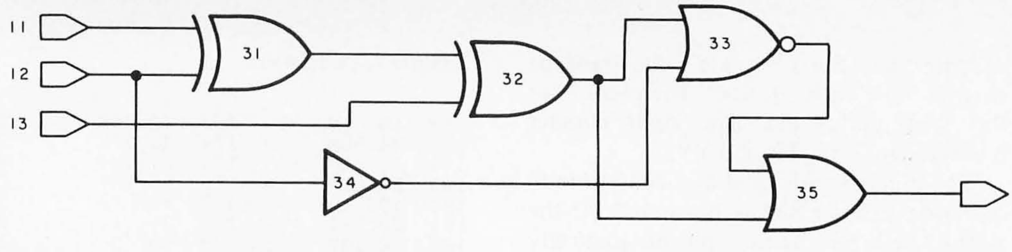
A → 11	A' → 15
B → 12	B' → 16
C → 13	C' → 17
D → 14	D' → 18

Listing 1, continued:

```
119  10  10
120  44 SUM
121  10  10
122  63 EX*
123  10  10
124  50 I×I
125  22 INV
126  67  EQ
127  28 LOG
128  76 LBL
129  39 COS
130  22 INV
131  86 STF
132  00  00
133  63 EX*
134  10  10
135  03  3
136  00  0
137  42 STO
138  10  10
139  76 LBL
140  33 X²
141  43 RCL
142  10  10
143  85  +
144  01  1
145  95  =
146  66 PAU
147  42 STO
148  10  10
149  73 RC*
150  10  10
151  67  EQ
152  23 LNX
153  22 INV
154  77  GE
155  33 X²
156  55  ÷
157  01  1
158  00  0
159  00  0
160  00  0
161  00  0
162  95  =
163  42 STO
164  27  27
165  59 INT
166  22 INV
167  44 SUM
168  27  27
169  42 STO
170  26  26
171  73 RC*
172  26  26
173  77  GE
174  38 SIN
175  22 INV
176  59 INT
177  65  ×
178  01  1
179  00  0
180  94 +/-
181  95  =
182  42 STO
183  30  30
184  01  1
185  00  0
186  00  0
187  49 PRD
188  27  27
189  43 RCL
190  27  27
191  59 INT
192  22 INV
193  44 SUM
194  27  27
195  42 STO
196  26  26
197  73 RC*
198  26  26
199  77  GE
200  38 SIN
201  22 INV
202  59 INT
203  65  ×
204  01  1
205  00  0
206  94 +/-
207  95  =
208  42 STO
209  29  29
210  43 RCL
211  27  27
212  65  ×
213  01  1
214  00  0
215  00  0
216  95  =
217  59 INT
218  42 STO
219  09  09
220  71 SBR
221  35 1/X
222  63 EX*
223  10  10
224  59 INT
225  74 SM*
226  10  10
227  01  1
228  94 +/-
229  64 PD*
230  10  10
231  61 GTO
232  33 X²
233  76 LBL
234  23 LNX
235  87 IFF
236  00  00
237  39 COS
238  43 RCL
239  30  30
240  91 R/S
241  81 RST
242  76 LBL
243  11  A
244  32 X:T
245  01  1
246  01  1
247  42 STO
248  10  10
249  61 GTO
250  42 STO
251  91 R/S
252  76 LBL
253  12  B
254  32 X:T
255  01  1
256  02  2
257  42 STO
258  10  10
259  61 GTO
260  42 STO
261  76 LBL
262  13  C
263  32 X:T
264  01  1
265  03  3
266  42 STO
267  10  10
268  61 GTO
269  42 STO
270  76 LBL
271  14  D
272  32 X:T
273  01  1
274  04  4
275  42 STO
276  10  10
277  61 GTO
278  42 STO
279  76 LBL
280  16 A'
281  32 X:T
282  01  1
283  05  5
284  42 STO
285  10  10
286  61 GTO
287  42 STO
288  76 LBL
289  17 B'
290  32 X:T
291  01  1
292  06  6
293  42 STO
294  10  10
295  61 GTO
296  42 STO
297  76 LBL
298  18 C'
299  32 X:T
300  01  1
301  07  7
302  42 STO
303  10  10
304  61 GTO
305  42 STO
306  76 LBL
307  19 D'
308  32 X:T
309  01  1
310  08  8
311  42 STO
312  10  10
313  61 GTO
314  42 STO
315  91 R/S
316  76 LBL
317  42 STO
318  01  1
319  94 +/-
320  72 ST*
321  10  10
322  32 X:T
323  65  ×
324  93  .
325  01  1
326  95  =
327  22 INV
328  74 SM*
329  10  10
330  65  ×
331  01  1
332  00  0
333  95  =
334  91 R/S
```

Set Up

Register	Contents
31	111270
32	311370
33	323450
34	121260
35	323330
36	0



Truth Table			
11	12	13	OUTPUT
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Figure 1: Example of a digital circuit simulation. All of the logic gates are numbered sequentially. In this circuit there are three inputs (11, 12, 13) and one output. The set up of the registers is shown, along with a truth table which is a result of running the program and giving different inputs to 11, 12 and 13.

The circuit in figure 1 demonstrates the principles involved.

Note that the code number for each device type is the actual line number for the subroutine that simulates that device. Since memory is at a premium, each device was programmed in as short as possible sequence that obtained the desired result. No attempt was made to follow any structured programming techniques!

Also, the calculator is programmed to assert only those devices whose inputs are connected to devices that are asserted. Therefore, circuits with feedback (like the crossed-NOR flip flop) cannot be directly simulated. Note that program runs faster in natural order of circuit evaluation.

This program uses some of the more advanced programming features of the TI-59 calculator, such as indirect addressing and flag operations. However, the program is straightforward and should be fairly easy to understand for most novice programmers.

The advantage of the simulator, of course, is the ease of setting up and quickly changing any reasonable circuit. No power supply is required and no purchasing of components is required until the circuit is thoroughly acceptable on the simulator.

The program is stored on both edges of one card. The data on a particular circuit can be stored on a card by pressing "3 2nd Write."■

BYTE's Bits

Another Life

I've discovered a fourth glider and two new oscillators for Jonathan Millen's "One-Dimensional Life" (December 1978 BYTE, page 68). The new glider has period 5; it evolves from hexadecimal location 65F. My first new oscillator can be made by starting with either 394F or 22 cells in a row — it has period 13. The other oscillator, with period 21, has the ancestor 12157.

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Call For Papers: Sixth Data Communications Symposium

The Sixth Data Communications Symposium, scheduled for November 27 thru 29 in Pacific Grove CA, will concentrate on the design of systems for network user services. Original research and development papers are being solicited for topics related either to the application of specific technical issues that arise from the application nature of a data communication system, or to the application of general technical problems that are directly applicable to the planning, analysis, and design of the systems across the boundary between applications. Four copies of a completed paper and a 500 word summary should be sent no later than April 1 to Dr Wushow Chou, North Carolina State University, Computer Studies Program, POB 5490, Raleigh NC 27650. Include name, address, phone number, and affiliation. All papers will be refereed and authors of selected papers will be notified by June 1, 1979. All papers accepted for presentation will be published in the conference proceedings.■

Data Transfer

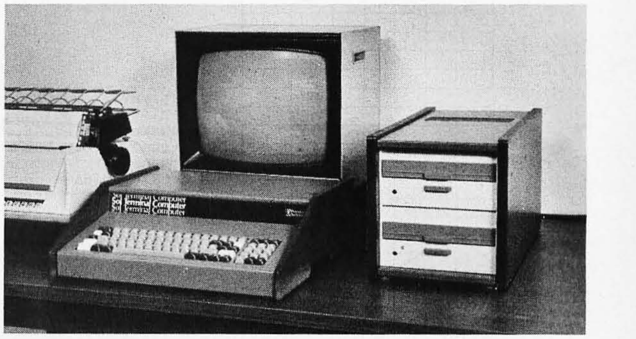
It is practical to transfer programs directly from one microcomputer to another computer over the telephone without intermediate storage by using readily available equipment. Specifically, I have read TRS-80 BASIC programs into the CSU-Long Beach PDP 11/45 operating under RSTS. The terminal used was a 33 ASR Teletype with an AJ 260 acoustic coupler. The Small Systems Hardware RS-232 interface unit was used to output from the TRS-80.

Many terminals have an auxillary or similar connector for attaching other RS-232 devices to the terminal. The trick is to connect pin 3 of the TRS-80 RS-232 output to pin 2 of this plug. (Normally, pin 3 would be connected to pin 3 of the auxillary connector if the terminal is to be used as a printer. The other pins connections remain the same but probably only pin 7 is needed.) After establishing contact with the PDP 11/45 an LLIST command to the TRS-80 causes it to output directly to the PDP 11/45. In my case, the PDP 11/45 checked each statement as it was entered and could send back error messages to the Teletype. Since the operation was full duplex without echo this did not interfere with the data transmission from the TRS-80. If a half duplex system is used it is essential that there be no turn-around on the line during transmission since the TRS-80 does not stop until the end of the LLIST. The program is immediately executable on the PDP 11/45.

A 10,000 byte program was transmitted in 17 minutes at 110 baud. Obviously a higher rate could be used to speed up the process.

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The Power of the HP-67 Programmable Calculator, Part 2

Example Program

Last month I described the features and performance of the Hewlett-Packard HP-67 and HP-97 programmable calculators. This month I conclude with a practical application program. I have chosen for an example a program which uses the more powerful HP-67 operations. Likewise, I have chosen to write a program which will provide the solution to a general set of simultaneous equations, traditionally one of the most laborious mathematical solutions to obtain, yet one of the most useful solutions in electrical engineering.

The HP Math Pac contains a program to solve four simultaneous equations in four unknowns by Gaussian elimination, and the Standard Pac contains a program to solve three simultaneous equations in three unknowns by matrix operations. The program shown in listing 1 solves any system of up to nine simultaneous equations in nine unknowns by the method of "Gaussian elimination using the largest pivots." *[Because of its efficiency, the Guassian elimination pivot method is a popular method for solving simultaneous equations. The term "pivot" refers to the (r, r), a diagonal element of the coefficient matrix during the rth step of the process. This method is discussed in a number of numerical methods books. See also the reference at the end of this article. . .CM]* The primary utility of this program would be in calculator aided design.

When the analysis of an electronic system is based upon a linear model, the unknown quantities will usually appear only to the first power, and the coefficients in the equations will usually be constants. Such a set of n equations relating n unknowns can be expressed in the form:

Equation 1: $A_1X_1+A_2X_2+...+A_nX_n = Y_1$

Equation 2: $B_1X_1+B_2X_2+...+B_nX_n = Y_2$

Equation 3: ... ...

Equation n: $m_1X_1+m_2X_2+...+m_nX_n = Y_n$

Listing 1: A simultaneous equations program which can solve systems of up to nine equations in nine unknowns. Listing 2 explains how to run this program.

PROGRAM TITLE: Simultaneous Equations

APPLICATION: Solves systems of up to 9 simultaneous equations.

PROGRAMMER: Bob Arp DATE: 12-16-76

REGISTERS

0 Yn	1 A9	2 A8	3 A7	4 A6	5 A5	6 A4	7 A3	8 A2	9 A1
S0 Yn	S1 A9	S2 A8	S3 A7	S4 A6	S5 A5	S6 A4	S7 A3	S8 A2	S9 A1

A #Eqs in System	B Pri reg Pointer	C Sec reg Pointer	D Pivotal Eq Counter	E Equation Counter	I Misc Storage

LABELS					FLG	SET STATUS		
A Part 1 Start	B Divide	C Mult/ Subtract	D Part 2 Start	E Mult/ Subtract	0	FLAGS ON / OFF	TRIG	DISP
a B/C initial	b Clear R0-R9	c Recall term	d Mult/ Sub Loop	e	1		DEG	FIX
0 Divide Loop	1 Test D	2 Mult Loop	3 Call Sub a	4 Sub Loop	2		GRA	SCI
								ENG
5 1st term loop	6 Inc E/ Dec D	7 Disp X #	8 Call next piv	9 Disp Xn	3		RAD	n 5

NUM ADD	NUMERIC			SYMBOLIC			DEFINITIONS AND REMARKS
001	31	25	11	f	LBL	A	With the number of system equations keyed into the calculator, pressing A initializes part 1 of the program by clearing all registers, storing n, programming the display and calling for the first pivotal equation.
002		31	43	f	CLR	REG	
003		31	42		f	P⇄S	
004		31	43	f	CLR	REG	
005		35	23		h	ENG	
006		33	11		STO	A	
007			01			1	
008		33	14		STO	D	
009		23	05		DSP	5	
010		35	22		h	RTN	
011	31	25	12	f	LBL	B	With a pivotal equation stored in the primary registers, pressing B causes each coefficient of the equation to be divided by its pivotal term. The results are stored in the secondary registers, and they must be stored on a data card labeled 1A(Z), where Z is the number of the current system of equations.
012	32	22	11	g	GSB	f a	
013		34	24		RCL	(i)	
014		33	15		STO	E	
015	31	25	00	f	LBL	0	
016		34	12		RCL	B	
017	32	22	13	g	GSB	f c	
018		34	15		RCL	E	
019			81			÷	
020		34	13		RCL	C	
021		35	33		h	ST I	
022		35	53		h	Rv	
023		33	24		STO	(i)	
024		34	12		RCL	B	
025		31	51		f	X=0	
026		22	01		GTO	1	
027			01			1	Decrement register pointers and return to beginning of loop.
028			51			-	
029		33	12		STO	B	
030		34	13		RCL	C	
031			01			1	
032			51			-	
033		33	13		STO	C	
034		22	00		GTO	0	
035	31	25	01	f	LBL	1	When all pivotal equations have been divided by their pivotal term, jump to display n loop.
036		34	11		RCL	A	
037		34	14		RCL	D	
038		32	51		g	X=Y	
039		22	09		GTO	9	
040		34	14		RCL	D	Initialize equation counter and clear primary registers R0-R9.
041			01			1	
042			61			+	

Listing 1 continued on opposite page.

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in which each X is an unknown quantity, the m terms are the coefficients of the unknowns and the Y terms are the right-hand sides of the equations.

The Gaussian Elimination Pivot Method

To solve a general system of simultaneous equations by Gaussian elimination using the largest pivots, perform the following steps:

1. Inspect the coefficient (A_1, B_1,...m_1) of the first term (X_1) in each of the system equations. The equation having the largest coefficient (in absolute value) of the first term is taken as the first pivotal equation.

2. Divide the first pivotal equation, equation 1(1), by the coefficient A_1 of its first term X_1. The result will be a new equation, equation 1A (1), in which the coefficient of the first term is 1. (The digit enclosed by parentheses in each equation label indicates the number of the system to which the equation belongs.)

3. Multiply equation 1A(1) by the coefficient B_1 of the first term X_1 of the second equation, equation 2(1) to obtain the new equation, equation 1B(1).

4. Subtract equation 1B(1) from the second equation, equation 2(1), to eliminate the first term of equation 2(1). The resulting equation will be one of the equations in a new system with n−1 equations in n−1 unknowns.

5. Repeat steps 3 and 4 with each of the remaining equations in the original system. The set of equations, for which the first term has been eliminated, forms a new system having n−1 equations with X_2, X_3,...X_n as unknowns.

6. Inspect the coefficient of the first term in each of the new system's equations. The equation having the largest coefficient (in absolute value) of the first term is taken as the next pivotal equation.

7. Divide the new pivotal equation by the coefficient of its first term. The result will be a new A equation in which the coefficient of the first term is 1.

8. Multiply the new A equation by the

Listing 1, continued:

NUM ADD	PROGRAM CODES NUMERIC			SYMBOLIC			DEFINITIONS AND REMARKS
043		33	15		STO	E	
044	32	22	12	g	GSB	f b	
045		31	41	f	W/	DATA	
046		35	22		h	RTN	
047	31	25	13	f	LBL	C	With the coefficients of equation 1A(Z) stored in the secondary registers and the coefficients of each remaining equation in the current system stored, in turn, in the premary registers, pressing C causes each coefficient of equation 1A(Z) to be multiplied by the first coefficient of each remaining equation, in turn, to yield a new equation, 1B(Z), where Z is the number of the current system of equations. Equation 1B(Z) is then subtracted from the current remaining equation, eliminating the first coefficient of the current remaining equation. The result of processing a system in this manner is a new set of equations which has a number of unknowns that is one less than the number of unknowns in the system that is presently being processed.
048	32	22	11	g	GSB	f a	
049		34	24		RCL	(i)	
050	31	25	02	f	LBL	2	
051		34	13		RCL	C	
052	32	22	13	g	GSB	f c	
053		35	52		h	X⪢Y	
054			71			x	
055		33	24		STO	(i)	
056			01			1	
057			00			0	
058		34	13		RCL	C	
059		32	51		g	X=Y	
060		22	03		GTO	3	
061		35	82	h	LST	X	
062		34	13		RCL	C	
063			01			1	
064			51			-	
065		33	13		STO	C	
066		35	53		h	Rv	
067		22	02		GTO	2	
068	31	25	03	f	LBL	3	
069	32	22	11	g	GSB	f a	
070	31	25	04	f	LBL	4	
071		34	12		RCL	B	
072	32	22	13	g	GSB	f c	
073		34	13		RCL	C	
074	32	22	13	g	GSB	f c	
075			51			-	
076		33	24		STO	(i)	
077			01			1	
078			00			0	
079		34	13		RCL	C	
080		32	51		g	X=Y	If all terms of the current equation have been processed, jump to fLBL 5.
081		22	05		GTO	5	
082			01			1	Decrement register pointers and return to beginning of loop.
083			51			-	
084		33	13		STO	C	
085		34	12		RCL	B	
086			01			1	
087			51			-	
088		33	12		STO	B	
089		22	04		GTO	4	
090	31	25	05	f	LBL	5	Stores the address of the first coefficient of each equation of the new system in register I.
091		34	14		RCL	D	
092			01			1	
093			61			+	
094		33	14		STO	D	
095		34	11		RCL	A	
096		34	14		RCL	D	
097			51			-	
098			01			1	
099			01			1	
100			61			+	
101		35	33		h	ST I	
102		34	14		STO	D	
103			01			1	
104			51			-	
105		33	14		STO	D	
106		34	24		RCL	(i)	Recalls the first coefficient of each equation of the new system, stores the absolute value of the coefficient in I and displays the absolute value for 5 seconds with a flashing decimal point.
107		35	64		h	ABS	
108		35	33		h	ST I	
109		31	84		f	-x-	
110		34	11		RCL	A	
111		34	15		RCL	E	If all equations of the current system have been processed, jump to "call for next pivotal equation."
112		32	51		g	X=Y	
113		22	08		GTO	8	
114			01			1	
115			61			+	Update E register and clear primary registers R0-R9.
116		33	15		STO	E	
117	32	22	12	g	GSB	f b	
118		31	41	f	W/	DATA	
119		35	22		h	RTN	
120	31	25	08	f	LBL	8	
121	32	22	12	g	GSB	f b	Calls for the next pivotal equation.
122		34	14		RCL	D	
123			01			1	
124			61			+	
125		33	14		RCL	D	
126		31	41	f	W/	DATA	
127		35	22		h	RTN	
128	31	25	09	f	LBL	9	Displays n with flashing decimal point in a continuous loop when Xn has been computed.
129		34	11		RCL	A	
130		31	84		f	-x-	

Listing 1 continued on next page.

Listing 1, continued:

NUM ADD	PROGRAM CODES NUMERIC			SYMBOLIC			DEFINITIONS AND REMARKS
131		22	09		GTO	9	
132			84			R/S	
133	31	25	14	f	LBL	D	Stores Xn in R1 and initiates second part of program.
134		31	42		f	P⇆S	
135		34	00		RCL	0	
136		33	01		STO	1	
137			00			0	
138		33	00		STO	0	
139			01			1	
140		33	15		STO	E	
141		35	22		h	RTN	
142	31	25	15	f	LBL	E	As each 1A equation is stored in the secondary registers, a new unknown is computed and stored in a primary register until all unknowns are stored. See the calculator RUN worksheet for the method of storage.
143			01			1	
144			00			0	
145		35	33		h	ST I	
146		34	24		RCL	(i)	
147		33	00		STO	0	
148			01			1	
149		33	12		STO	B	
150			01			1	
151			01			1	
152		33	13		STO	C	
153	32	25	14	g	LBL	f d	
154		34	00		RCL	0	
155		34	12		RCL	B	
156	32	22	13	g	GSB	f c	
157		34	13		RCL	C	
158	32	22	13	g	GSB	f c	
159			71			x	
160			51			-	
161		33	00		STO	0	
162		34	15		RCL	E	
163		34	12		RCL	B	
164		32	51		g	X=Y	
165		22	06		GTO	6	
166		34	12		RCL	B	
167			01			1	
168			61			+	
169		33	12		STO	B	
170		34	13		RCL	C	
171			01			1	
172			61			+	
173		33	13		STO	C	
174	22	31	14		GTO	f d	
175	31	25	06	f	LBL	6	Updates registers D and E.
176		34	15		RCL	E	
177			01			1	
178			61			+	
179		33	15		STO	E	
180		35	33		h	ST I	
181		34	00		RCL	0	
182		33	24		STO	(i)	
183		34	14		RCL	D	
184			01			1	
185			51			-	
186		33	14		STO	D	
187	31	25	07	f	LBL	7	Displays the number of the unknown X which has been computed in a continuous loop.
188		34	14		RCL	D	
189		31	84		f	-x-	
190		22	07		GTO	7	
191			84			R/S	
192	32	25	11	g	LBL	f a	SUBROUTINE a: Initializes B and C registers every time a new pivotal equation is stored in the primary registers and B is pressed. Initializes B and C registers every time a new equation of the current system is stored in the primary registers and C is pressed, or program control jumps to subtract loop.
193		34	11		RCL	A	
194		34	14		RCL	D	
195			51			-	
196			01			1	
197			61			+	
198		35	33		h	ST I	
199		33	12		STO	B	
200			01			1	
201			00			0	
202			61			+	
203		33	13		STO	C	
204		35	22		h	RTN	
205	32	25	12	g	LBL	f b	SUBROUTINE b: Resets primary registers R0-R9.
206			00			0	
207		33	00		STO	0	
208		33	01		STO	1	
209		33	02		STO	2	
210		33	03		STO	3	
211		33	04		STO	4	
212		33	05		STO	5	
213		33	06		STO	6	
214		33	07		STO	7	
215		33	08		STO	8	
216		33	09		STO	9	
217		35	22		h	RTN	
218	32	25	13	g	LBL	f c	Calls each term of equation being processed in proper order.
219		35	33		h	ST I	
220			44			CLX	
221		34	24		RCL	(i)	
222		35	22		h	RTN	
223			84			R/S	
224							

CALCULATOR PROGRAM CONTINUATION WORKSHEET — TREBOR ENGINEERING

coefficient of the first term of the second system equation to obtain a new B equation.

9. Subtract the new B equation from the second system equation to eliminate the first term of the second system equation. The resulting equation will be one of the equations in a new system which has one less unknown than the system being processed.

10. Repeat steps 8 and 9 with each of the remaining equations in the system being processed. The resulting set of equations, from which the first term has, again, been eliminated, forms a new system of equations having one less unknown and one less equation than the preceding system.

11. Repeat steps 6 thru 10 until a final set is obtained which consists of the single equation:

$$ZX_n = Y_n.$$

Being the only equation in the system, it must, of course, be the pivotal equation. When this pivotal equation is divided by the coefficient of its first term, the value of X_n will be known.

12. The value for X_n must then be substituted into the (n–1)A equation and the equation must be solved for $X_{(n-1)}$.

13. The values which have been obtained for X_n and $X_{(n-1)}$ must then be substituted into the (n–2)A equation and the equation solved for $X_{(n-2)}$.

14. Continue in this manner until the 1A equation is solved for X_1 of the original system of equations after substituting the values obtained for all other unknowns.

15. The solution should be checked by substituting the values obtained for the unknowns into each equation of the original system, performing the indicated multiplications, additions and subtractions, and comparing the left side of the equation to the right side. They should be reasonably close to equality.

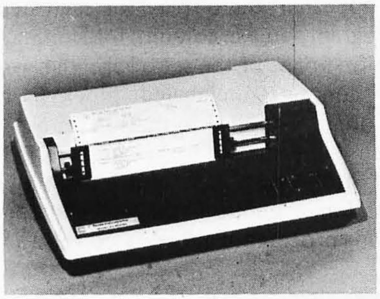
In electronics engineering, the system of simultaneous equations could be the result of writing the mesh equations for a circuit such as that shown in figure 1. The nine mesh equations for this circuit are listed in table 1.

The system of nine simultaneous equations for the circuit are shown in standard form in table 2. The first pivotal equation is equation 1. The unknowns in a system of mesh equations are the currents. The right side of each equation is a summation of the voltage sources in the mesh represented by the equation.

The instructions for running the simultaneous equations program in listing 1 are shown in listing 2. Using the system of nine

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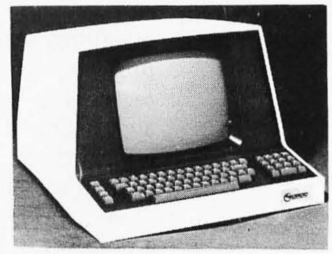


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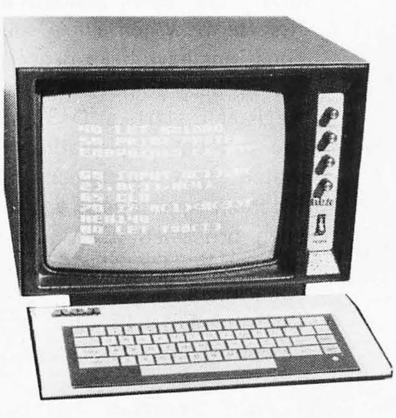
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equations (table 2) in a sample run of the program, listing 3 shows the contents of the registers at various points in the program, and listing 4 summarizes the original coefficients of the equations plus the calculated currents.

A "check" program and its instructions are shown in listings 5 and 6. Note that the quantity obtained for the left side of the equation may not be exactly equal to the right side due to round off approximations.

The "simultaneous equations" program of listing 1 calculates the values of the unknowns for any system containing no more than nine equations. The program is listed on calculator program worksheets upon which the addresses of program memory are preprinted. In addition, the program worksheets have labeled columns for listing the symbolic key codes, the numeric codes which appear in the display for each step of the program, and a column for comments.

The first page of the set of program worksheets contains prelabeled blocks which allow other useful information about the program to be stored. For example, the first section of listing 1 contains the following information about the simultaneous equations program in abbreviated form:

Mesh 1: $-40 + 1I_1 + 2(I_1 - I_2) + 3(I_1 - I_3) = 0$
Mesh 2: $2(I_2 - I_1) + 4I_2 + 5(I_2 - I_4) + 6(I_2 - I_3) = 0$
Mesh 3: $3(I_3 - I_1) + 6(I_3 - I_2) + 7(I_3 - I_5) = 0$
Mesh 4: $5(I_4 - I_2) + 8I_4 + 9(I_4 - I_6) + 10(I_4 - I_5) = 0$
Mesh 5: $7(I_5 - I_3) + 10(I_5 - I_4) + 11(I_5 - I_7) = 0$
Mesh 6: $9(I_6 - I_4) + 12I_6 + 13(I_6 - I_8) + 14(I_6 - I_7) = 0$
Mesh 7: $11(I_7 - I_5) + 14(I_7 - I_6) + 15(I_7 - I_9) = 0$
Mesh 8: $13(I_8 - I_6) + 16I_8 + 17I_8 + 18(I_8 - I_9) = 0$
Mesh 9: $15(I_9 - I_7) + 18(I_9 - I_8) + 19I_9 = 0$

Table 1: The nine equations for the circuit shown in figure 1.

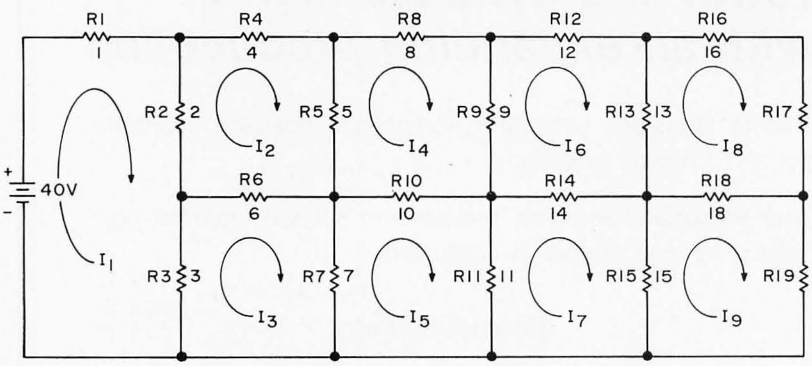


Figure 1: An example of the type of circuit for which nine mesh equations may be written. The resulting system of equations contains nine unknown currents.

Equation 1:	$6I_1$	$-2I_2$	$-3I_3$	$+0I_4$	$+0I_5$	$+0I_6$	$+0I_7$	$+0I_8$	$+0I_9$	$=40$
Equation 2:	$-2I_1$	$+17I_2$	$-6I_3$	$-5I_4$	$+0I_5$	$+0I_6$	$+0I_7$	$+0I_8$	$+0I_9$	$= 0$
Equation 3:	$-3I_1$	$-6I_2$	$+16I_3$	$+0I_4$	$-7I_5$	$+0I_6$	$+0I_7$	$+0I_8$	$+0I_9$	$= 0$
Equation 4:	$0I_1$	$-5I_2$	$+0I_3$	$+32I_4$	$-10I_5$	$-9I_6$	$+0I_7$	$+0I_8$	$+0I_9$	$= 0$
Equation 5:	$0I_1$	$+0I_2$	$-7I_1$	$-10I_4$	$+28I_5$	$+0I_6$	$-11I_7$	$+0I_8$	$+0I_9$	$= 0$
Equation 6:	$0I_1$	$+0I_2$	$+0I_3$	$-9I_4$	$+0I_5$	$+48I_6$	$-14I_7$	$-13I_8$	$+0I_9$	$= 0$
Equation 7:	$0I_1$	$+0I_2$	$+0I_3$	$+0I_4$	$-11I_5$	$-14I_6$	$+40I_7$	$+0I_8$	$-15I_9$	$= 0$
Equation 8:	$0I_1$	$+0I_2$	$+0I_3$	$+0I_4$	$+0I_5$	$-13I_6$	$+0I_7$	$+64I_8$	$-18I_9$	$= 0$
Equation 9:	$0I_1$	$+0I_2$	$+0I_3$	$+0I_4$	$+0I_5$	$+0I_6$	$-15I_7$	$-18I_8$	$+52I_9$	$= 0$

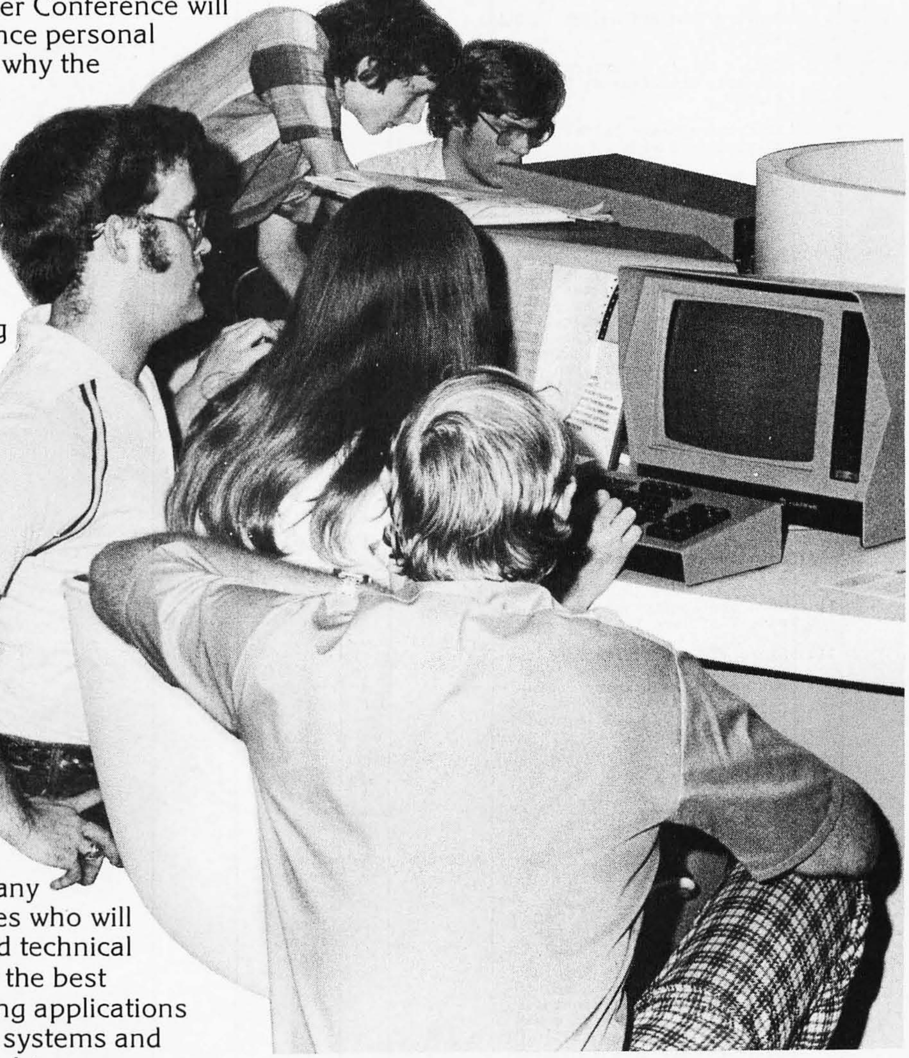
Table 2: The nine simultaneous equations for the circuit in figure 1, shown here in standard form (ie: with the variables arranged in order for each equation).

A. Registers
  1. Registers R0 thru R9 and RS0 thru RS9 are used to store constants in a sequence that is reversed from the order in which they appear in the equations of each system. Note: Processing the first system (n equations) yields a system of n-1 equations; processing the second system (n-1 equations) yields a system of n-2 equations; . . . processing the nth system (1 equation) yields X_n.
  2. Register A is used to store the number of equations in the original system of simultaneous equations.
  3. Register B is used as a pointer for the registers R0 thru R9; register C is used as a pointer for the registers RS0 thru RS9. Registers B and C are decremented in a manner which allows constants to be indirectly recalled from the primary and secondary storage registers so that, using these constants, mathematical operations may be performed upon each equation of each system.
  4. Register D starts at 1 and counts the number of pivotal equations that have been divided by their first term. When D=A, all pivotal equations have been processed, and X_n has been computed.
  5. Register E starts at D+1 and counts the number of equations in each system that have been processed. When all equations of a system have been processed, E=A and the display calls for the next pivotal equation.
  6. Register I takes care of miscellaneous temporary storage.

B. Labels

The main program has two parts which are actually subdivided into several smaller programs. Furthermore, most of the subprograms contain one or more subroutines which are used to conserve program steps.

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Listing 2: Detailed instructions for running the simultaneous equations program in listing 1.

PROGRAM TITLE: Simultaneous Equations					
APPLICATION: Solves Systems of up to 9 equations					
PROGRAMMER: Bob Arp				DATE: 12-16-76	
STEP NO.	INSTRUCTIONS AND REMARKS	INPUTS		OUTPUTS	
		LABEL	KEY	DISPLAY	CARD
1.	Turn calculator on.				
2.	Place W/PRGM-RUN switch in RUN position.			0.00	
3.	Insert side 1 of program card labeled "Simultaneous Equations".			crd	
4.	When crd appears in the display, insert side 2.			0.00000 00	
5.	Key in number of equations in the system.		n	n.	
6.	Press A.	START PART I	A	1.00000 00	
7.	The "1.00000 00" which appears in the display calls for the coefficients of the first pivotal equation to be stored in the primary registers. Store A1(1) in Rn, A2(1) in Rn-1,...,An(1) in R1, and Y1(1) in R0. Coefficients which are zero need not be stored. The "(1)" refers to the first system.		A1(1) STO n A2(1) STO n-1 ... An(1) STO 1 Y1(1) STO 0		
8.	Press B.	DIVIDE	B	crd	
9.	When crd appears in the display insert side 1 of card 1A(1), where "(1)" is the number of the current pivotal equation (and system) being processed.			crd	
10.	When crd appears again, insert side 2 of card 1A(1).			0.00000	1A(1)
11.	Store the coefficients of the second equation of the first system in the primary registers. Store B1(1) in Rn, B2(1) in Rn-1,...,Bn(1) in R1 and Y2(1) in R0.		B1(1) STO n B2(1) STO n-1 ... Bn(1) STO 1 Y2(1) STO 0		
12.	Press C.	MULT/SUB.	C	m1(w)(2) Displayed for 5 seconds with flashing decimal point.	
13.	When flashing decimal point appears, record the absolute value of the coefficient for the first term of each equation, w, of the new system, 2, as it appears in the display. If the coefficient is missed while the decimal point is flashing, it may be recalled by pressing h RCI after step 15, before proceeding with step 16.			crd	
14.	When crd appears in the display, insert side 1 of card w(2).			crd	
15.	When crd appears in the display again, insert side 2 of card w(2).			0.00000 00	w(2)
16.	Insert side 2 of card 1A(1).	1A(1)		crd	
17.	When crd appears in the display press CLX.		CLX.	0.00000 00	
18.	Store the next equation of the current system, 1, in the primary registers. Store m1(x) in Rn, m2(x) in Rn-1, ...,mn(x) in R1 and Yx in R0, where, x is the number of the equation in system 1 currently being processed.	In General,	m1(x) STO Rn m2(x) STO Rn-1 ... mn(x) STO R1 Y(x) STO		

Listing 2 continued on next page.

1. Subprogram A: initiates the first part of the main program.
2. Subprogram B: divides pivotal equations by their first term and outputs an A equation.
3. Subprogram C: multiplies A equations by the coefficient of the first term of each succeeding system equation, subtracts the results of the multiplication from that equation and outputs the equations of a new system.
4. Subprogram D: initiates the second part of the main program.
5. Subprogram E: operating upon the A equations, computes X_1 thru $X_{(n-1)}$ by multiplying the previously computed X values by their constants and subtracting the results from the right side of the A equation.
6. Subroutine a: initializes B and C registers every time B is pressed after a new pivotal equation is stored in the primary registers and every time C is pressed after a new equation is stored in the primary registers.
7. Subroutine b: clears registers R0 thru R9 to 0.
8. Subroutine c: recalls each term of the equation being processed in the proper order.
9. Loops d, 0, 2, 4: these loops allow the same mathematical operation to be performed many times within the same subprogram.
10. Routine 1: compares the contents of D to the contents of A and transfers execution to routine 9 when D=A.
11. Routine 3: a short routine which calls subroutine a.
12. Routine 5: stores the address of the first coefficient of each equation of the new system being generated in register I, then recalls the coefficient, stores its absolute value in I, and finally displays the absolute value of the coefficient for 5 seconds.
13. Routine 6: increments E register and decrements D register in the second part of the main program.
14. Routine 7: displays the number of the unknown X which has been computed in a continuous loop until R/S is pressed.
15. Routine 8: calls for the next pivotal equation by displaying its number.

Listing 2, continued:

STEP NO.	INSTRUCTIONS AND REMARKS	INPUTS		OUTPUTS	
		LABEL	KEY	DISPLAY	CARD
19.	GO TO step 12 until the digit "2.00000 00" appears in the display, calling for the second pivotal equation. A new pivotal equation must be stored in the primary registers each time the program halts automatically and displays a digit, Z, indicating the desired pivotal equation. When the pivotal equation digit is displayed, the decimal point will not be flashing, nor will the digit be displayed in a continuous loop. The digit, Z, is also the number of the system being processed. The first pivotal equation must be stored by using the keyboard. Subsequent pivotal equations are stored by inserting a data card.		0	2.00000 00	
20.	The new pivotal equation is that equation of the new system, Z, for which the largest (in absolute value) first term has been observed. This equation, as are the other equations of the new system, Z, is stored on a magnetic card.				
21.	Insert side 2 of the card which contains the new pivotal equation.	1(Z)		crd	
22.	When crd appears in the display, press CLX.		CLX	2.00000 00	
23.	Press f P≷S.		f P≷S	2.00000 00	
24.	Press B.	DIVIDE	B	crd	
25.	When crd appears in the display, insert side 1 of card 1A(Z).			crd	
26.	When crd appears again, insert side 2 of card 1A(Z).			0.00000 00	1A(Z)
27.	Press f P≷S.		f P≷S	0.00000 00	
28.	Insert side 2 of card w(Z) [Card w(Z) no longer needed], where w is the equation of the system, Z, currently being processed.	w(Z)		crd	
29.	When crd appears in the display, press CLX.		CLX	0.00000 00	
30.	Press f P≷S.		f P≷S	0.00000 00	
31.	Press C.			m1(w)(Z+1) Displayed for 5 seconds with flashing decimal point.	
32.	When flashing decimal point appears, record the absolute value of the coefficient for the first term of each equation, w, of the system being created. If the coefficient is missed while the decimal point is flashing, it may be recalled by pressing h RCI after step 34, before proceeding with step 35.			crd	
33.	When crd appears in the display, insert side 1 of w(Z+1).			crd	
34.	When crd appears in the display again, insert side 2 of card w(Z+1).			0.00000 00	w(Z+1)
35.	Insert side 2 of card 1A(Z).	1A(Z)		crd	
36.	When crd appears in the display press CLX.		CLX	0.00000 00	
37.	GO TO step 27 until a new digit "Z.00000 00" appears in the display, calling for the next pivotal equation.				
38.	When the new digit "Z.00000 00" appears in the display, GO TO step 21. Eventually, the digit "n.00000 00" will appear in the display. The nth pivotal equation is the only equation				

Listing 2 continued on opposite page.

16. Routine 9: displays the value of X_n with flashing decimal in a continous loop until R/S is pressed.

C. Display
The information under DISP indicates that engineering notation has been selected and that numbers appearing in the display will be rounded off to five significant digits after the first one. When engineering notation is selected, numbers are shown in the display with exponents of 10 that are multiples of 3. As with all HP-67 display formats (unless f RND is pressed), calculations are performed using full 10 digit numbers (10 digit mantissa and 2 digit exponent of 10).

The instructions to be used while running the simultaneous equations program, shown in listing 2, are listed on calculator run worksheets. These worksheets list the manual steps which must be followed to obtain the solution to the system of equations, inputs you must supply to the calculator by pressing keys or inserting cards, and outputs from the calculator in the display or on cards.

Although it might appear that many magnetic cards are needed to run the program, note that cards containing the equations of a system are no longer needed after the equations have been processed with the pivotal equation of the system. Therefore, these cards may then be used to record the equations of another system.

These instructions are self-explanatory (I hope), therefore, I will allow them to speak for themselves. Please note, however, that the instructions contain loops that refer you to steps previously accomplished. Remember that n pivotal equations must be processed and each equation contained in a pivotal's system must be processed with the pivotal equation.

As a further aid in understanding both the program and the HP-67, listing 3 shows what is stored in each register after selected program steps. The calculator register worksheets illustrated in these figures are a valuable debugging tool and serve as explicit program documentation.

All of the forms shown in this article, except the one shown in listing 4, may be used with any HP-67 (and with other calculators as well) program. The form shown in listing 4 has been prepared specifically for simultaneous equations. This worksheet can be used to list the constants of the original system of equations, to record the first terms of each of the other systems as they appear in the display so that the pivotal equations may be easily spotted, and finally, to record the value of each unknown.

Conclusion

With the help of special forms designed for the occasion, the powerful repertoire of the HP-67 (and the HP-97) has been examined, yet I have taken from you none of the pleasures in store as you begin your adventures with this versatile calculator.

The example program presented will be an added attraction to those anticipating the purchase of an HP-67, as well as to those fortunates who already possess one. When you look at the price tag on the HP-67, compare its cost to the cost of computer time and memory which would be necessary to run similar programs. In addition, think of the programs you could run on the HP-67 which might never be run otherwise.

Listing 2, continued:

STEP NO.	INSTRUCTIONS AND REMARKS	INPUTS LABEL	INPUTS KEY	OUTPUTS DISPLAY	OUTPUTS CARD
	in system n, therefore, no first term comparisons need be made. Furthermore, the nth pivotal equation need not be stored on a card. Since the nth pivotal equation is now stored in the secondary registers, simply press f P≷S.		f P≷S	n.00000 00	
39.	Press B.	DIVIDE	B	n.00000 00 Displayed with flashing decimal in a continuous loop.	
40.	The "n.00000 00" displayed with flashing decimal in a continuous loop indicates that Xn has been computed and is stored in RS0.				
41.	Press R/S.		R/S	n.00000 00	
42.	Press D.	START PART II	D	1.00000 00	
43.	Insert side 2 of card 1A(n-1).	1A(n-1)		crd	
44.	When crd appears in the display, press CLX.		CLX	1.00000 00	
45.	Press E.		E	n-1.000000 Displayed with flashing decimal in a continuous loop.	
46.	The "n-1.000000" displayed with flashing decimal in a continuous loop indicates that Xn-1 has been computed and is stored in R2 (Xn is now stored in R1).				
47.	Press R/S.		R/S	n-1.000000	
	...				
48.	Insert side 2 of card 1A(1).	1A(1)		crd	
49.	When crd appears in the display, press CLX.		CLX	2.00000 00	
50.	Press E.		E	1.00000 00 Displayed with flashing decimal in a continuous loop.	
51.	The "1.00000 00" displayed with flashing decimal in a continuous loop indicated that X1 has been computed and is stored in Rn.				
52.	Press R/S.	END	R/S	1.00000 00	
53.	Recall each X value from the primary registers by pressing R1 through R9.		RCL 1	Xn	
			RCL 2	Xn-1	
			...	...	
			RCL n	X1	

CALCULATOR RUN WORKSHEET TREBOR ENGINEERING

REFERENCES

Kuo, Benjamin C, *Linear Networks and Systems*, McGraw-Hill, New York, 1967, pages 63 to 104. A good discussion of introductory network theory.

Pearson, Carl (ed), *Handbook of Applied Mathematics*, Van Nostrand, New York, 1974, pages 906 to 908. Gives a treatment of the Gaussian elimination method.

Listings 3, 4, 5 and 6 are continued on pages 186 and 188.

Listing 3: Selected register worksheets for the sample program discussed in the text. These sheets illustrate the contents of the registers at various key points in the program.

PROGRAM TITLE: 9 Equation Example
APPLICATION: Calculator-Aided Design
PROGRAMMER: Bob Arp — DATA CARD LABEL: None
LAST PROGRAM STEP: 010 — NEXT PROGRAM STEP: 011

EQUATION:			EQUATION:			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000 00		RS0	0.00000 00		A	9.00000 00	
R1	0.00000 00		RS1	0.00000 00		B	0.00000 00	
R2	0.00000 00		RS2	0.00000 00		C	0.00000 00	
R3	0.00000 00		RS3	0.00000 00		D	1.00000 00	
R4	0.00000 00		RS4	0.00000 00		E	0.00000 00	
R5	0.00000 00		RS5	0.00000 00		I	0.00000 00	
R6	0.00000 00		RS6	0.00000 00		X	1.00000 00	
R7	0.00000 00		RS7	0.00000 00		Y	9.00000 00	
R8	0.00000 00		RS8	0.00000 00		Z	0.00000 00	
R9	0.00000 00		RS9	0.00000 00		T	0.00000 00	
						LSX		

PROGRAMMER: — DATA CARD LABEL: EQ. 1A(1)
LAST PROGRAM STEP: 046 — NEXT PROGRAM STEP: 047

EQUATION:			EQUATION: 1A(1)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	6.66667	Y	A	9.00000	
R1	0.00000		RS1	0.00000	A9	B	0.00000	
R2	0.00000		RS2	0.00000	A8	C	10.00000	
R3	0.00000		RS3	0.00000	A7	D	1.00000	
R4	0.00000		RS4	0.00000	A6	E	2.00000	
R5	0.00000		RS5	0.00000	A5	I	10.00000	
R6	0.00000		RS6	0.00000	A4	X	0.00000	
R7	0.00000		RS7	-.500000	A3	Y	2.00000	
R8	0.00000		RS8	-.333333	A2	Z	1.00000	
R9	0.00000		RS9	1.00000	A1	T	9.00000	
						LSX		

PROGRAMMER: — DATA CARD LABEL: 1(2)
LAST PROGRAM STEP: 119 — NEXT PROGRAM STEP: 120

EQUATION:			EQUATION: 1(2)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	13.33333	Y	A	9.00000	
R1	0.00000		RS1	0.00000	A8	B	0.00000	
R2	0.00000		RS2	0.00000	A7	C	10.00000	
R3	0.00000		RS3	0.00000	A6	D	1.00000	
R4	0.00000		RS4	0.00000	A5	E	3.00000	
R5	0.00000		RS5	0.00000	A4	I	16.33333	
R6	0.00000		RS6	-5.00000	A3	X	0.00000	
R7	0.00000		RS7	-7.00000	A2	Y	3.00000	
R8	0.00000		RS8	16.33333	A1	Z	9.00000	
R9	0.00000		RS9	0.00000		T	16.33333	
						LSX		

PROGRAMMER: — DATA CARD LABEL: 2(2)
LAST PROGRAM STEP: 119 — NEXT PROGRAM STEP: 120

EQUATION:			EQUATION: 2(2)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	20.00000	Y	A	9.00000	
R1	0.00000		RS1	0.00000	B9	B	0.00000	
R2	0.00000		RS2	0.00000	B8	C	10.00000	
R3	0.00000		RS3	0.00000	B7	D	1.00000	
R4	0.00000		RS4	0.00000	B6	E	4.00000	

Listing 3 continued on next page.

Listing 3, continued:

R5	0.00000		RS5	-7.00000	B5	I	-7.00000	
R6	0.00000		RS6	0.00000	B4	X	0.00000	
R7	0.00000		RS7	14.50000	B3	Y	4.00000	
R8	0.00000		RS8	-7.00000	B2	Z	9.00000	
R9	0.00000		RS9	0.00000	B1	T	-7.00000	
						LSX		

PROGRAMMER: | DATA CARD LABEL: 1A(2)

LAST PROGRAM STEP: 046 | NEXT PROGRAM STEP: 047

EQUATION:			EQUATION: 1A(2)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	.816327	Y	A	9.00000	
R1	0.00000		RS1	0.00000	A9	B	0.00000	
R2	0.00000		RS2	0.00000	A8	C	10.00000	
R3	0.00000		RS3	0.00000	A7	D	2.00000	
R4	0.00000		RS4	0.00000	A6	E	3.00000	
R5	0.00000		RS5	0.00000	A5	I	10.00000	
R6	0.00000		RS6	-.306122	A4	X	0.00000	
R7	0.00000		RS7	-.428571	A3	Y	3.00000	
R8	0.00000		RS8	1.00000	A2	Z	2.00000	
R9	0.00000		RS9	0.00000	A1	T	9.00000	
						LSX		

PROGRAMMER: | DATA CARD LABEL: 1(3)

LAST PROGRAM STEP: 119 | NEXT PROGRAM STEP: 120

EQUATION:			EQUATION: 1(3)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	25.7143	Y	A	9.00000	
R1	0.00000		RS1	0.00000	A9	B	0.00000	
R2	0.00000		RS2	0.00000	A8	C	10.00000	
R3	0.00000		RS3	0.00000	A7	D	2.00000	
R4	0.00000		RS4	0.00000	A6	E	4.00000	
R5	0.00000		RS5	-7.00000	A5	I	11.50000	
R6	0.00000		RS6	-2.14286	A4	X	0.00000	
R7	0.00000		RS7	11.50000	A3	Y	4.00000	
R8	0.00000		RS8	0.00000	A2	Z	9.00000	
R9	0.00000		RS9	0.00000	A1	T	11.50000	
						LSX		

PROGRAMMER: | DATA CARD LABEL: 1(9)

LAST PROGRAM STEP: 127 | NEXT PROGRAM STEP: 128

EQUATION:			EQUATION: 1(9)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	8.16534	Y1	A	9.00000	
R1	0.00000		RS1	36.9574	A9	B	0.00000	
R2	0.00000		RS2	0.00000	A8	C	10.00000	
R3	0.00000		RS3	0.00000	A7	D	9.00000	
R4	0.00000		RS4	0.00000	A6	E	9.00000	
R5	0.00000		RS5	0.00000	A5	I	36.9574	
R6	0.00000		RS6	0.00000	A4	X	9.00000	
R7	0.00000		RS7	0.00000	A3	Y	0.00000	
R8	0.00000		RS8	0.00000	A2	Z	9.00000	
R9	0.00000		RS9	0.00000	A1	T	9.00000	
						LSX		

PROGRAMMER: | DATA CARD LABEL: 1A(9)

LAST PROGRAM STEP: 130 | NEXT PROGRAM STEP: 131

EQUATION:			EQUATION: 1A(9)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	-8.16534		RS0	.220939	Y	A	9.00000	
R1	36.9574		RS1	1.00000	A9	B	0.00000	
R2	0.00000		RS2	0.00000	A8	C	10.00000	
R3	0.00000		RS3	0.00000	A7	D	9.00000	
R4	0.00000		RS4	0.00000	A6	E	36.9574	
R5	0.00000		RS5	0.00000	A5	I	10.00000	
R6	0.00000		RS6	0.00000	A4	X	9.00000	
R7	0.00000		RS7	0.00000	A3	Y	9.00000	
R8	0.00000		RS8	0.00000	A2	Z	9.00000	
R9	0.00000		RS9	0.00000	A1	T	9.00000	
						LSX		

APPLICATION: D has just been pressed to initiate Part II.

PROGRAMMER: | DATA CARD LABEL:

LAST PROGRAM STEP: 141 | NEXT PROGRAM STEP: 142

EQUATION:			EQUATION:			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	0.00000		RS0	8.16534		A	9.00000	
R1	.220939	I9	RS1	36.9574		B	0.00000	
R2	0.00000		RS2	0.00000		C	10.00000	
R3	0.00000		RS3	0.00000		D	9.00000	
R4	0.00000		RS4	0.00000		E	1.00000	
R5	0.00000		RS5	0.00000		I	-.220939	
R6	0.00000		RS6	0.00000		X	1.00000	
R7	0.00000		RS7	0.00000		Y	0.00000	
R8	0.00000		RS8	0.00000		Z	-.220939	
R9	0.00000		RS9	0.00000		T	-.220939	
						LSX		

PROGRAMMER: | DATA CARD LABEL:

LAST PROGRAM STEP: 189 | NEXT PROGRAM STEP: 190

EQUATION:			EQUATION: 1A(8)			COUNTERS AND CONSTANTS		
REG	CONTENTS	LBL	REG	CONTENTS	LBL	REG	CONTENTS	LABEL
R0	.140633		RS0	.0645869		A	9.00000	
R1	.220939	I9	RS1	-.344197		B	1.00000	
R2	.140633	I8	RS2	1.00000		C	11.00000	
R3	0.00000		RS3	0.00000		D	8.00000	
R4	0.00000		RS4	0.00000		E	2.00000	
R5	0.00000		RS5	0.00000		I	2.00000	
R6	0.00000		RS6	0.00000		X	8.00000	
R7	0.00000		RS7	0.00000		Y	8.00000	
R8	0.00000		RS8	0.00000		Z	8.00000	
R9	0.00000		RS9	0.00000		T	8.00000	
						LSX		

CALCULATOR REGISTER WORKSHEET   TREBOR ENGINEERING

Listing 4: A special simultaneous equations worksheet showing the constants of the original nine equations of the sample problem discussed in the text. The first terms of each of the intermediate systems are shown along with the solution.

TITLE: Nine Equations Example   PAGE 1 OF 1

APPLICATION: Solves systems of up to 9 simultaneous equations   DATE: 12/27/76

SYSTEM 1 CONSTANTS

EQ #	m1	m2	m3	m4	m5	m6	m7	m8	m9	Y
1	6	-2	-3	0	0	0	0	0	0	40
2	-2	17	-6	-5	0	0	0	0	0	0
3	-3	-6	16	0	-7	0	0	0	0	0
4	0	-5	0	32	-10	-9	0	0	0	0
5	0	0	-7	-10	28	0	-11	0	0	0
6	0	0	0	-9	0	48	-14	-13	0	0
7	0	0	0	0	-11	-14	40	0	-15	0
8	0	0	0	0	0	-13	0	64	-18	0
0	0	0	0	0	0	0	-15	-18	52	0
REG	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0

FIRST TERMS (ABSOLUTE VALUE)

EQ #	SYSTEM								VARIABLES	
	2	3	4	5	6	7	8	9	X1	9.12165
1	16.3333	11.5000	30.0701	19.4895	44.7189	28.1314	59.4605	.220939	X2	2.49275
2	7.0000	2.1428	11.3043	3.3834	15.9096	4.6250	20.4661		X3	3.24814
3	5.0000	7.0000	9.0000	11.0000	13.0000	15.0000			X4	.928924
4	0.0000	0.0000	0.0000	0.0000	0.0000				X5	1.37839
5	0.0000	0.0000	0.0000	0.0000					X6	.386434
6	0.0000	0.0000	0.0000						X7	.597162
7	0.0000	0.0000							X8	.140634
8	0.0000								X9	.220939

SIMULTANEOUS EQUATIONS WORKSHEET   TREBOR ENGINEERING

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Listing 5: Instructions for running the program in listing 6 which checks the solutions obtained by the program in listing 1.

Blank coding forms like the ones used in this article may be purchased from Robert C Arp Jr, 3961 Acapulco Dr, Campbell CA 95008.

Listing 6: A program which accepts the coefficients calculated by listing 1 and checks them for accuracy.

Listing 5

PROGRAM TITLE: Simultaneous Equations Check Program				PAGE 1 OF 2	
APPLICATION: Checks solutions to systems of up to 9 equations					
PROGRAMMER: Bob Arp				DATE: 12-27-76	
STEP NO.	INSTRUCTIONS AND REMARKS	INPUTS		OUTPUTS	
		LABEL	KEY	DISPLAY	CARD
1.	Before the check program can be initiated, all values of X must be stored in the primary registers as follows: X1 in Rn, X2 in R(n-1),...,Xn in R1. The values of X are stored in this manner at the end of the "SIMULTANEOUS EQUATIONS" program.				
2.	Key in the number of system equations.		n	n.	
3.	Press A.	START	A	n.00000 00	
4.	Store the coefficients of equation 1 into the primary registers as follows: A1 in Rn, A2 in R(n-1),...,An in R1. Constants which are zero need not be entered.	EQ 1	A1 STO Rn A2 STO Rn-1 ... An STO R1		
5.	Press B.	MULT/ADD	B	≈Y1 Displayed with flashing decimal in a continuous loop.	
6.	Press R/S.	HALT	R/S	≈Y1	
7.	The number which appears in the display should be approximately equal to Y1.				
8.	Store the coefficients of equation 2 in the primary registers as follows: B1 in Rn, B2 in R(n-1),...,Bn in R1. Constants which are zero need not be entered.	EQ 2	B1 STO Rn B2 STO Rn-1 ... Bn STO R1		
9.	Press B.	MULT/ADD	B	≈Y2 Displayed with flashing decimal in a continuous loop.	
10.	Press R/S.	HALT	R/S	≈Y2	
11.	The number which appears in the display should be approximately equal to Y2.				
	...				
12.	Store the coefficients of equation n in the primary registers as follows: m1 in Rn, m2 in R(n-1),...,mn in R1.	EQ n	m1 STO Rn m2 STO Rn-1 ... mn STO R1		
13.	Press B.	MULT/ADD	B	≈Yn Displayed with flashing decimal in a continuous loop.	
14.	Press R/S.	END	R/S	≈Yn	
15.	The number which appears in the display should be approximately equal to Yn.				

CALCULATOR RUN WORKSHEET TREBOR ENGINEERING

Listing 6

PROGRAM TITLE: SIMULTANEOUS EQUATIONS CHECK PROGRAM PAGE 1 OF 2

APPLICATION: Checks solutions to systems of up to 9 equations.

PROGRAMMER: Bob Arp DATE:

REGISTERS

0	1	2	3	4	5	6	7	8	9
	m9	m8	m7	m6	m5	m4	m3	m2	m1
S0	S1 X9	S2 X8	S3 X7	S4 X6	S5 X5	S6 X4	S7 X3	S8 X2	S9 X1

A	B	C	D	E	I
# Eqs in System	Pri reg pointer	Sec reg pointer	Term counter	Y storage	Misc storage

LABELS

					FLG
A Start	B Mult/Add	C	D	E	0
a	b	c	d	e	1
0 Mult/add loop	1 Clear registers	2 Disp loop	3	4	2

SET STATUS

FLAGS ON	FLAGS OFF	TRIG	DISP
		DEG	FIX
		GRA	SCI
			ENG X
		RAD	n 5

NUM ADD	NUMERIC			SYMBOLIC			DEFINITIONS AND REMARKS
001	31	25	11	f	LBL	A	With all values of X stored in primary registers and with the number of system equations keyed into the calculator, pressing A initializes the check program by storing the values of X in the secondary registers and clearing the primary registers.
002		23	05		DSP	5	
003		35	23		h	ENG	
004		31	42		f	P⇄S	
005		31	43	f	CL	REG	
006		33	11		STO	A	
007		35	22		h	RTN	
008	31	25	12	f	LBL	B	When the program halts and displays the number of system equations, the coefficients of the first system equation must be stored in the primary registers; coefficients which are zero need not be stored. The coefficients must be stored in the registers as indicated above under the "REGISTERS" heading (see CALCULATOR RUN WORKSHEET).
009		34	11		RCL	A	
010		33	12		STO	B	
011		33	14		STO	D	
012			01			1	
013			00			0	
014			61			+	
015		33	13		STO	C	
016			00			0	During subsequent halts, the coefficients of the other system equations are stored, in turn, in the primary registers.
017			41			↑	
018		33	15		STO	E	
019	31	25	00	f	LBL	0	After the coefficients of an equation have been stored, pressing B causes each value of X to be multiplied by the appropriate constant, and the sum of the multiplications to be stored in register E. The Multiply/Add loop continues until the term counter, D, indicates that n terms have been processed.
020		34	12		RCL	B	
021		35	33		h	ST I	
022			44			CLX	
023		34	24		RCL	(i)	
024		34	13		RCL	C	
025		35	33		h	ST I	
026			44			CLX	
027		34	24		RCL	(i)	
028			71			x	
029		34	15		RCL	E	
030			61			+	
031		33	15		STO	E	
032			01			1	
033		34	14		RCL	D	
034		32	51		g	X=Y	
035		22	01		GTO	1	
036			01			1	
037			51			-	
038		33	14		STO	D	
039		34	12		RCL	B	
040			01			1	
041			51			-	
042		33	12		STO	B	
043		34	13		RCL	C	
044			01			1	
045			51			-	
046		33	13		STO	C	
047		22	00		GTO	0	
048	31	25	01	f	LBL	1	Clears primary registers; allows the next system equation to be stored with no attention paid to the coefficients which are zero.
049			00			0	
050		33	00		STO	0	
051		33	01		STO	1	
052		33	02		STO	2	
053		33	03		STO	3	
054		33	04		STO	4	
055		33	05		STO	5	
056		33	06		STO	6	
057		33	07		STO	7	
058		33	08		STO	8	
059		33	09		STO	9	
060	31	25	02	f	LBL	2	Recalls the value of the Y term stored in E and displays this value with a flashing decimal point in a continuous loop; pressing R/S breaks the loop and displays Y.
061		34	15		RCL	E	
062		31	84		f	-x-	
063		22	02		GTO	2	
064			84			R/S	
065							
066							
.							
.							
.							
080							

CALCULATOR PROGRAM CONTINUATION WORKSHEET TREBOR ENGINEERING

■

Nybbles

BASIC Cross-Reference Table Generator

William and Alice Englander
1966 Titus St
San Diego CA 92110

A standard compiler feature for high level languages like COBOL and PL/I is a cross-reference of the source program. In the simplest case, each named element in the program is listed in a report with the line numbers of all statements containing that element. Words which have special meanings in the language being cross-referenced, such as READ or IF, are ignored.

Features of more sophisticated cross-reference facilities include placing the elements in alphabetical order, showing the statement number in which an element is defined separate from its references, defining the use of the element as a sending or receiving field and cross-referencing both data elements and procedural elements (statement labels).

As we began program development in BASIC on our microprocessor, we discovered the pleasures of using BASIC, but were surprised to find that cross-references of our BASIC programs could not be produced with any of our regular system software. In addition, our survey of the literature did not turn up any BASIC cross-reference programs.

A cross-reference can be an extremely useful programming aid. When you are debugging a program, it allows you to quickly find each statement which deals with a particular variable. For example, if the program is looping you can look at each reference of the loop control variable to ensure that it has been initialized, that it is being incremented, and that a check for the upper limit is being made. A cross-reference is

Text continued on page 192.

```
CBASIC BSGAME
CBASIC COMPILER VER 1.01
   1:      PRINT "BINARY SEARCH GAME"
   2:      PRINT
   3:      INPUT "HIT RETURN WHEN READY TO PLAY";LINE ANS$
   4:      RANDOMIZE
   5: 10   LOW=1
   6:      HIGH=1000
   7:      NO=INT(RND*HIGH)+1
   8:      FOR I=1 TO 24
   9:         PRINT
  10:         NEXT I
  11: 20   PRINT
  12:      PRINT "ENTER NUMBER IN THE RANGE";LOW;"THROUGH";HIGH
  13:      INPUT GUESS
  14:      IF (GUESS<LOW) OR (GUESS>HIGH) OR (GUESS<>INT(GUESS)) THEN\
  15:         PRINT "TRY AGAIN":\
  16:         GO TO 20
  17:      IF GUESS<NO THEN\
  18:         LOW=INT(GUESS+1):\
  19:         PRINT "YOU'RE LOW":\
  20:         GO TO 20
  21:      IF GUESS>NO THEN\
  22:         HIGH=INT(GUESS-1):\
  23:         PRINT "YOU'RE HIGH":\
  24:         GO TO 20
  25:      PRINT "YOU WIN!!!"
  26:      PRINT
  27:      PRINT "PLAY AGAIN?"
  28:      INPUT ANS$
  29:      IF LEFT$(ANS$,1)="Y" THEN\
  30:         GO TO 10
  31:      PRINT "END OF BINARY SEARCH GAME"
  32:      STOP
  33:      END
NO ERRORS DETECTED


CRUN XREF
CRUN VER 1.03


ENTER NAME OF PROGRAM TO BE CROSS-REFERENCED BSGAME

CROSS-REFERENCE LISTING OF PROGRAM B:BSGAME.BAS
VARIABLE                REFERENCES
I                       8    10
NO                      7    17   21
LOW                     5    12   14   18
ANS$                    3    28   29
HIGH                    6    7    12   14   22
GUESS                   13   14   14   14   14   17   18   21   22
```

Listing 1: An example program with a cross-reference table generated by the BASIC cross-reference generator program.

About the Authors

William and Alice Englander have a programming and consulting firm in the San Diego area. While most of their program development is done on customers' large scale computers, they also do work for customers on their IMSAI 8080 disk based system. They are both computer systems instructors at National University.

Text continued from page 190:

handy when you need to make a program change, too. You can quickly see what names have already been used if you need to define a new variable. And you can double check your planned changes against uses of the existing variables, which may enable you to use existing ones instead of having to define new ones.

In BASIC, a cross-reference listing can be especially useful in helping you to verify that you have used correct names in your code. Since BASIC sets up variables for you without requiring explicit definitions, you can accidentally miscode a variable name and cause some elusive program problems. A quick look at the cross-reference would alert you right away since you would see both the correct name and the improperly coded name.

Our BASIC cross-reference program was written using C-BASIC on an IMSAI 8080 disk based system running under CP/M. Depending on your configuration, enhancements could probably be made which would speed up the processing time. A typical program and cross-reference table is shown in listing 1 on the preceding page.■

The Nybbles Library is an inexpensive means for BYTE readers to share some interesting but specialized forms of software. These programs are written by readers with small computers and printer facilities, and are therefore designed for particular systems. The algorithms and programming techniques can be used by readers with similar equipment, or can serve as an inspiration for improvisation on computers of different characteristics.

Potential authors of such programs should send us a self-addressed stamped envelope, with a request for a copy of our Guidelines for Nybbles Authors. *Payment for Nybbles items is based on sales and length of the item. Rates are set at the time of acceptance.*

Nybbles Library programs are sent in listing form, printed on 8.5 by 11 inch paper on both sides. The Nybbles Library programs are punched with three holes for collection in loose leaf binders, and come in an attractive folder which serves as a cover. This month the BASIC Cross-Reference Table Generator *has been added to the Nybbles Library. You can order a personal copy of this program (BYTE Nybbles Library Document #105) for $.75 postpaid ($1.05 overseas postpaid) by filling out the coupon on the preceding page.*

BYTE's Bugs

Motor Source Error

A list of stepping motor sources in "A Stepping Motor Primer, Part 1: Theory of Operation," by Paul Giacomo (February 1979 BYTE, page 90) was incomplete. We omitted Superior Electric Co, 383G Middle St, Bristol CT 06010, a major manufacturer of stepping motors.■

Polyphony Made Accurate

Perusal of my copy of the January 1979 BYTE, containing my article "Polyphony Made Easy," reveals two errors in the schematic on page 106.

First the trivial one: the counters are incorrectly labeled as 7473 (in fact, both are called IC10a). They are, in reality, 7493s.

Second, the multiplexers — all nine of them — have a pinout error. Instead of "B A C" along the bottom of each one (input address), they should read "A B C," with the pin numbers changed accordingly to "11 to 9."

These are not crippling errors — anyone who's reasonably familiar with TTL (transistor-transistor logic) would spot the first one immediately, and the second would cause scrambled key codes but would sooner or later be figured out.

Steven K Roberts
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Louisville KY 40206■

Finishing the Job

The Programming Quickie "Single Stepping the 8080 Processor" (January 1979 BYTE, page 179) has one small bug in it. A line of code was left out of the program listing on page 180. The last line of the program should read: 118A JMP FINI C37D10.■

BYTE News . . . .

32 Bit Microprocessors Are Rumored. While Zilog and Motorola are struggling to get their 16 bit microprocessor-ICs into production, Texas Instruments and Intel have been delivering theirs for some time. Now rumors abound that both TI and Intel will show prototype 32 bit processors by the end of the year and may be in production by the end of 1980 or the beginning of 1981.

Tremendous Growth of Personal Computer Systems Predicted for 1979. Mike Shea, marketing director for Atari, who recently brought two personal computer systems to the market, predicts a four to sixfold increase in personal computer sales for this year. He feels that between 200,000 and 300,000 personal computer systems will be sold this year, compared to 50,000 last year, and said that in the future Atari will pay less attention to developing new game consoles and instead concentrate on bringing out new software for existing units.

Fairchild Camera & Instruments predicts that 4.6 million programmable video games will be sold this year, worldwide, compared to 2.1 million in 1978. Further, they predict that 18 million cartridges, worth $110 million, will be sold, compared to 5.7 million, worth $18 million, last year.

Nonvideo games growth should prove even more dynamic, according to industry pundits. Sales should reach $290 million in 1979, and possibly $500 million in 1980.

Lear Seigler Shipped 40,000 Video Terminals in 1978. The Data Products division of Lear Seigler announced that in 1978 they shipped 40,000 video display terminals. This was more than they shipped in their six previous years of doing business. LS is predicting an increase in video display sales in 1979 of 25 to 30 percent.

Centronix Reports 20 Percent of Its Printers Go to Personal Computer Makers. Centronix, the leading maker of dot matrix printers, predicts that about 20 percent of its 1979 business will be from Tandy (Radio Shack TRS-80) and from Apple Inc. At the beginning of the year they were shipping 1700 printers per month to Tandy (in other words, 20,400 per year). Centronix is getting set to introduce a high density dot matrix printer and a word processing impact printer to compete with Diablo and Queme.

Computer Stores Becoming Big Business. Computer stores are becoming mass merchandisers, judging by an order recently placed with Perkin-Elmer Corp. Their terminal division announced that Micro-Age, a chain of five computer stores in Arizona and Texas, placed an order with them for 2000 of their new Bantam video display terminals. That's a far cry from the garage-type computer store operations of just a year or two ago.

Battle Shaping Up in 32K EROM. In February 1978 Texas Instruments introduced its TMS 2532 4K by 8 EROM (erasable read only memory), with full production promised for April or May. This meant that they were well ahead of all the other integrated circuit manufacturers. They accepted orders for the device at $54 in 100 price lots. Intel introduced their 2732 erasable read only memory in November. Needless to say, the pinouts were different and a heated debate developed in the JEDEC committee over which would be the standard. TI hoped their 10 month lead would favor them. However, they encountered production problems and only started to deliver samples by year-end. Intel, in the meantime, is in production and has already lined up at least one second source. TI is promising production quantities by April. The unit price on the Intel part is currently $140. The 2732 also uses the same pinout as the 2716 and 2708 EROMs.

HP May Be Developing Personal Computer System. Hewlett-Packard is rumored to be developing a new personal computer system at its Corvallis Oregon Consumer Products division. HP has been selling a desktop computer with BASIC in read only memory and an IEEE-488 interface for a few years now. It is expected that the system will be a scaled down version of this system, that it will have a base price of $1000, and that it will be on the market this fall.

Tandy Developing New Computer. Tandy is rumored to be in development of a second generation Radio Shack TRS-80, possibly with color capability. Tandy, which has a 200,000 square foot plant and staff of 700 making the TRS-80, is supposedly looking for an outside manufacturer of the new system. Tandy also plans to develop many new software packages for introduction this year.

Magnavox Files Suit on Microprocessor Video Game Patents. Magnavox, the originator of video games played on home TV receivers, has filed suit against several manufacturers of programmable TV video games; among them

are Fairchild, Bally, Sears Roebuck and Montgomery Ward. Magnavox has won previous suits on dedicated, non-programmable video games. Some industry experts feel that if Magnavox is successful in this suit, the next step might be to try to license makers of personal computers that connect to home TV receivers.

DEC Forms Retail Products Group. Digital Equipment Corporation, the largest manufacturer of minicomputers, has formed a retail products group. Its initial objective is planning for expansion based on its successful experience with a retail store, which opened last August in Manchester NH. Located in a shopping mall, the store sells small computer systems starting at less than $10,000.

Flat Panel Displays Getting Closer to Production. Last month I reported on a flat panel terminal display being readied for production by General Telephone and Electronics. Several other companies have also announced that they have display panels in development. However, none appear near to replacing the present video displays, such as that of GT&E. Nonetheless, they are worth reviewing.

Datascreen Corp, of Mountain View CA, will soon start sampling a 40 character LCD (liquid crystal display) panel (5 by 10 dots) which works off 5 V and consumes 250 mW.

Westinghouse has already demonstrated a 180 by 180 line LCD panel for TV use. Hitachi has shown a 120 line panel. Neither, however, is near production.

Electroluminescent type panel samples are already available from Sharp. A 480 character display using a 7 by 9 dot matrix, with complete drive electronics, is currently available for $2500. A 240 by 320 dot graphics panel will be available next year.

ISSCC Gives Preview of New Technology Coming. The annual International Solid State Circuits Conference, held in Philadelphia, February 14 to 16, saw the presentation of new hardware technology still in the research and development stage. These devices will not be on the market for at least a year yet, and most are still 2 to 3 years off. But all are real and coming. Here's a partial list of some of those presented at the ISSCC:

> From Intel: a self-refreshing dynamic 4 K programmable memory with 200 ns access, an NMOS 4 K static programmable memory with 25 ns access, a 16 K HMOS static programmable memory with 45 ns access, a 5 V only 16 K dynamic programmable memory with 100 ns access and an analog I/O (input/output) microprocessor with on board erasable read only memory.
>
> From Texas Instruments: a simple 1 transistor cell.
>
> From Nippon Telephone and Telegraph: a 128 K bit read only memory and a megabit full wafer MOS programmable memory with 350 ns access.
>
> From Hitachi: a 1 K programmable memory with 5 ns access.

The Robots Are Taking Over. There are already about 20,000 robots at work in US factories. But this is just the beginning. Japan and several European countries are already ahead of the US in introducing manufacturing robots and automation under computer control.

Automation experts claim that in most manufacturing situations a product spends 95 percent of its time moving and waiting. Time is money. Hence, automation can cut this wasted time tremendously, effecting considerable savings.

Zilog Reports $18 million in Sales. Zilog, the creator and maker of the Z-80 processor, has reported sales for 1978 of $18 million. The company, which started in late 1975, and brought the Z-80 to the market in 1976, operated in the red in 1976 and 1977. A company spokesman said that in 1978 they were "at breakeven."

The Altair May Live Again. When Pertec bought MITS and its Altair line of PC system in 1977, they deserted the hobbyists who made the Altair a success. Pertec tried to change the Altair into a small business computer system. Things did not go too well. Pertec moved MITS from Albuquerque to California and then Pertec stopped making Altairs in June 1978. Pertec now is going to resurrect the Altair and start producing it again, in a new plant it is building in Albuquerque (of all places). Pertec plans to market it to small business users and not to personal computer users.

Computers Produce $350 Million Trade Surplus. It seems that all we read about in the newspapers are trade deficits. Well, last year the US exported $350 million in computer gear. Canada was the biggest purchaser ($12 million), and Japan was second ($10 million). Actually the US exported $406 million but imported $56 million in computer gear.

IBM Keeps Growing and Growing. When microcomputers came out and skyrocketed in popularity, many pundits predicted that IBM's domination of the computer business was coming to an end. However, that is not what has

happened. Today IBM has a larger backlog of orders than ever before. Their current backlog is more than four times the computing power it has ever shipped. Delivery time on its new 303X large computers is now over two years, and IBM has orders for about 13,000 of these machines, which replace large 370s.

Paper Newspapers and Mail May Soon Be a Thing of the Past. The ground work for a digital electronic mail system is now in the works. Imagine having your newspapers, magazines, bills, etc, delivered to you directly via your personal computer system, and likewise being able to write letters (with on line text editing, naturally) and then transmit them at the press of a button. It is already here in some large corporations and government agencies. But during the 1980s, this technology will explode into business offices and homes. It is rumored that TI, HP and IBM are developing personal computer systems specifically for these emerging applications.

Further, last December Xerox filed a petition with the FCC to develop a digital mail/communication system using microwave. It would provide for document distribution, data communication, etc, at rates up to 256 K bytes, which is far greater than current telephone systems and even than Bell's new T-carrier system now being installed. Xerox claims they will be able to deliver documents at less cost than the US mail. Each office desk would be equipped with a keyboard, video display, disk and processor; and would be able to do word processing, sorting, etc, in addition to mail handling. The mail handling naturally would be controlled by computer and hence include automatic addressing, priority routing, multipoint delivery, automatic transmission of previously stored messages, scan messages, etc.

GT&E is setting up a group to test market (in early 1980) a system to transmit data via telephone lines onto modified TV receivers in homes and offices. The system will be similar to the Viewdata systems currently under test by the British Postal System. GT&E is also negotiating for Viewdata licenses. ITT, TI and RCA reportedly are doing the same. TI, however, is currently testing a home information system in Salt Lake City that sends data over regular broadcast channels.

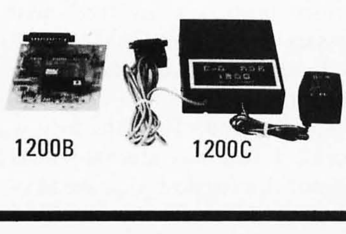
Also getting into the business is the US Postal Service, which last fall asked the US Postal Rate Commission for authority to offer an on line service called Electronic Computer Originated Mail (ECOM). ECOM is expected to start this year. The sender writes a "letter" on a terminal and sends it via telephone to the post office, who routes it to the destination post office where it is printed and delivered in the conventional way. This will be used mostly for mailing bills, overdue notices, etc.

This communications revolution will be boosted by the new Advanced Communications Service (ACS) for which AT&T recently received approval. ACS will lower data transmission costs and increase service. It will lower costs via shared communications facilities and make possible interfacing of incompatible terminals and computers and provide user selectable communications capabilities.

A few personal computer groups have already started a simple system called PCNET. The leading PCNET activity is run by the CACHE group (Chicago Area Computer Hobbyist Exchange). Other PCNET groups are functioning in the San Francisco, LA and Atlanta areas. The PCNET uses modems and telephone lines for communication. A writeup on PCNET appeared in the November 1978 BYTE.

Another personal computer approach has been taken by AMRAD (Amateur Radio Research and Development Corp) in McLean VA. They have established a bulletin board type system using telephone and 2 meter radio telephone.■

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Circle 12 on inquiry card.

Continued from page 6:

Another cause for possibility of losing files is just plain lack of experience with the system involved. A friend of mine who works at Digital Equipment Corporation tells the tale of how he once forgot which of several operating systems he was working on — and deleted a whole slew of files thanks to a "feature" known as wild card operations. Such operations are shortcuts to allow more than one file name to match the file name specified to the operating system. This friend's problem came from the fact that one PDP-11 operating system had a wild card specification that in another operating system was a unique specification.

There are more than just wild card opportunities for not understanding or forgetting how the operating system software works. There are many ways in which the user of any small computer can interfere in disk filing operations so that the file will be lost, or a whole disk file directory will be lost. For example, all it takes is the simple removal of the disk from the drive or resetting of the computer while an operation is being performed. Thus the fundamental rule of small computer and big computer use is "don't touch the computer during a disk (or tape or any other filing) operation."

But when you introduce the possibility of physical errors due to imperfect media, the whole problem gets complicated, and sometimes such a simplistic rule has to be violated. My problem may have resulted from the facts that I have been using one floppy disk for three months solidly and that I was updating a file one stormy winter day. Because floppy disk media are contact media, they are indeed subject to wear. Whether it was wear or the wiles of Peterborough Flicker And Flash division of New Hampshire Public Service, on the day of the disaster I got a little message from the physical I/O disk drivers which support the operating system.

It was an ominous message, for several reasons. First, it occurred during a "krunch" operation which is the UCSD Pascal system's disk file compression program. Second, it occurred after the last file had been moved, so it was most likely during a directory write operation. Third, it was one of these frustrating situations where an apparently infinite retry loop was involved, with one error message coming every 15 or 20 seconds. So, I violated the rule stated above and reset the computer.

That was the end. The directory was no longer valid, I had no alternate directory, and I had not the foggiest idea ahead of time about what to do to fix this situation. The

 Circle 297 on inquiry card.

directory included maybe 20 or 30 Pascal programs which I had written during the preceding month or so, including a really useful one called "littleblackbook." Well, in my experience using computers, the best course of action following such a disaster has always been to sit back and contemplate what has happened, to avoid compounding the problem with hastily conceived actions.

One thing was obvious. Only the directory had gotten zapped. This was confirmed by the use of some of the utility functions built into the UCSD Pascal system software: in the Filer portion of the system, one can scan for bad blocks on a disk, then enter a fixup routine to try and recover most of the data. The bad block was obviously in the directory, due to its physical location on the disk and that in using another copy of the system no directory could be found among the remaining data on the damaged disk. Knowing this, plus the fact that the files in the UCSD are stored contiguously on the disk, I knew that all the actual data was out there and that I just could not get at it through the normal directory methods.

But, if I could read the disk without the benefit of paying attention to such niceties as file structures, I would be able in principle to recover from this problem by writing a relatively simple program. Well, I proceeded to do exactly that. Since most of my data was in the form of programs, my first step was to write a program which would search arbitrary disk blocks in sequence from a starting block to the end of the disk. As each block was read by the program, I printed a confirmation message giving the current block number.

In this search, the program would look for the key word PROGRAM which begins every program's text file. When found, I would print out the first 20 characters of the file starting at the word PROGRAM. This would give me a physical block address directory of all the Pascal programs on the damaged disk. The program entitled Recover found in listing 1 accomplished this end for me, using the low level I/O procedures of UCSD Pascal called UNITREAD, UNITBUSY and UNITCLEAR. Output was directed to the screen and to the printer using the usual techniques of the 85/P implementation of UCSD Pascal: a control P character is intercepted from the keyboard to toggle on and off the output to the Diablo Hytype II printer I have on the system.

Once I had this printed directory of physical blocks which had the word "PRO-

GRAM" in them, I proceeded to modify and extend Recover until I had a second Pascal program called Grabber which would physically grab the good data from the damaged disk and write it on the new system disk as a file called A.TEXT. Grabber starts at a block address obtained by Recover's listing and transfers all data to the new file. This continues until a block is found containing the magical key word END. which marks the last line of every Pascal program in the system.

The text of Grabber is found in listing 2 accompanying this editorial. It has a couple of minor technical points worth noting. First, the UCSD Pascal system editor program tries to keep integral lines of text (marked by carriage return codes) within one block of 512 bytes of data. Since lines vary in size there is usually a segment of null data at the end of each block. Second, the UCSD Pascal system uses a form of data compression to eliminate redundant spaces at the beginning of each line of text in a file, so the first two bytes physically following a carriage return character are often (but not always) not text at all but codes indicating line compression. Thus in converting the file, the conversion program Grabber had to ignore all nonprinting characters except carriage returns and various combinations of characters following a carriage return.

The end result of running Grabber is always a file called A.TEXT, which I can then change to a name appropriate for the program being recovered. In this way, the new system disk could be restored with the contents of any program I wanted to use from the old disk. Now, of course, the old disk will never be modified in any way until I have recovered all the data I want from it.

The final version of the Grabber program as I wrote it is shown in listing 2a. It is still not perfect, for there are various strange combinations of carriage return and indentation codes which crop up when a file is recovered in this manner. It only handles the most common states of indentation codes. The exceptions are relatively benign, in that they get turned into arbitrary characters at the beginning of lines. These characters can in turn be edited out of the file after the grabber has completed its operation. Verification of the success of this strategy has been provided by several programs which compile and run as expected after transfer to new files using Grabber.

As for new operating procedures, I have now started to make a more regular practice of backing up files on my system disk. It turns out that there is no particular difficulty in transferring the entire contents of a

disk from one drive to another using the UCSD Pascal system's filer program. So, readers who wish to learn from my little fiasco should consider taking the time at least once per day to copy all the files on their main disk to a backup disk as a little bit of logical insurance against a serious filing system problem which may or may not ever happen. This is an important practice even if all you are using your computer for is fun and games, for every program that is ever written takes time and energy to create and type into a computer.

Listing 1: The first stage in the process of recovery from the directory zeroing disaster was to write an exploratory Pascal program called Recovery. The zapping of course only applied to the current system disk, copied from the master supplied with the system. Thus it was possible to make a new system disk for the purposes of compiling programs such as this one.

```
{Program to scan blocks on disk for text string "PROGRAM"}
-----------------------------------------------------------

PROGRAM recovery;
CONST
   disk = 5;
VAR
   blocknr,i,j : INTEGER;
   anychar : CHAR;
   buffer : PACKED ARRAY[0..511] OF CHAR;

   PROCEDURE initialize;
   BEGIN
      WRITELN('Enter starting block number for scan');
      READLN(blocknr);
      FOR j := 0 TO 511 DO buffer[j] := ' ';
   END {initialize};

   PROCEDURE findprogram;
   BEGIN
      WRITELN('Checking Block #',blocknr);
      UNITCLEAR(disk);
      UNITREAD(disk,buffer,512,blocknr,0);
      UNITWAIT(disk);
      j := 0;
      WHILE j < 480 DO
         BEGIN
            IF (
               (buffer[j+0]='P') AND
               (buffer[j+1]='R') AND
               (buffer[j+2]='O') AND
               (buffer[j+3]='G') AND
               (buffer[j+4]='R') AND
               (buffer[j+5]='A') AND
               (buffer[j+6]='M'))
            THEN
               BEGIN
                  FOR i := j TO j+20 DO WRITE(buffer[i]);
                  WRITELN('');
                  j := 505
               END;
            j := j + 1
         END;
      blocknr := blocknr + 1
   END {findprogram};

BEGIN {recovery}
   initialize;
   REPEAT
      findprogram
      UNTIL blocknr > 1100;
END. {recovery}
```

Listing 2: The second stage in the process of recovery was a modification and extension of the first program, now renamed Grabber. Once the earlier version of the program had printed out a rough listing of block numbers and names of programs, the program shown at (a) was created to transfer these files from the bad disk to a good disk. At (b) is shown an example run for recovery of a Pascal program of some 5 blocks in length.

(2a)

```
{program to copy physical IO files to "A.TEXT" text file}
PROGRAM grabtext;
CONST
   acarriagereturn = 13 {decimal integer equivalent of ASCII <CR>};
   indentcode = 16 {decimal integer equivalent of ASCII <DLE>};
   disk = 5 {physical unit address of righthand floppy drive};
VAR
   blockcount,blocknr,i,j,k : INTEGER;
   onecharacter,anychar : CHAR;
   buffer : PACKED ARRAY[0..511] OF CHAR;
   filename : STRING[32];
   ifoundareturn : (no,yes,spacecount);
   theoutput : FILE OF CHAR;

   PROCEDURE initialize;
      BEGIN
         blockcount := -1;
         ifoundareturn := no;
         WRITELN('Enter starting block number to grab from right drive');
         READLN(blocknr);
         filename := 'A.TEXT';
         WRITELN('Output will be to the file "A.TEXT"');
         WRITELN('Do you approve?');
         READ(KEYBOARD,anychar);
         WRITELN(anychar);
         IF anychar<>'y' THEN
            BEGIN
               WRITELN('When you have figured out what you want to do,',
               ' try me again');
               blocknr := 9999 {to force premature end of program}
            END;
         REWRITE(theoutput,filename)
      END {initialize};


   PROCEDURE makenormal;
      BEGIN {simply transfer if printing character}
         IF (
            (k >= ORD(' '))
               AND
            (k <= ORD('}'))
            )
         THEN
            WRITE(theoutput,onecharacter);
         ifoundareturn := no {--> first state}
      END {makenormal};

   PROCEDURE transferblock;
      BEGIN

      {first grab the block from the bad disk}
         WRITELN('Transferring Block #',blocknr);
         UNITCLEAR(disk);
         UNITREAD(disk,buffer,512,blocknr,0);
         UNITWAIT(disk);

      {then transfer the block to output file}
         FOR j := 0 TO 511 DO
            BEGIN
               onecharacter := buffer[j];

            {test for end of file}
               IF j>3 THEN
                  BEGIN
                     IF (
                        (buffer[j-3]='E') AND
                        (buffer[j-2]='N') AND
                        (buffer[j-1]='D') AND
                        (onecharacter = '.'))
                     THEN
                        BEGIN
                           WRITELN('I found END. in block #',blocknr);
                           blocknr := 2000
                        END
```

Listing 2a continued on opposite page.

Listing 2a, continued:

```
        { legal possibilities are as follows
            ... <any><any>...<any>
            ... <CR><CR> ...
            ... <CR><DLE><n><any> ...
            ... <CR><DLE><n><DLE><n>...<DLE><n><any>...
        }
            k := ORD(onecharacter);
            CASE ifoundareturn OF

                no:
                    IF k <> acarriagereturn THEN
                        makenormal
                    ELSE
                        BEGIN
                            WRITE(theoutput,onecharacter);
                            ifoundareturn := yes {--> next state}
                        END {IF...ELSE...};

                yes:
                    BEGIN
                        IF k=indentcode THEN
                            BEGIN
                                WRITE(theoutput,onecharacter);
                                ifoundareturn := spacecount {-->next state}
                            END
                        ELSE
                            BEGIN
                                IF k = acarriagereturn THEN {-->same state}
                                    WRITE(theoutput,onecharacter)
                                ELSE {-->first state}
                                    makenormal
                            END
                    END;

                spacecount:
                        BEGIN
                            WRITE(theoutput,onecharacter);
                            ifoundareturn := yes {--> previous state}
                        END
            END {CASE};
        END {FOR};
    blocknr := blocknr + 1
END {transferblock};

BEGIN {grabber}
   initialize;
   IF blocknr < 1103 THEN
      REPEAT

        {put an upper limit on number of blocks to transfer}
        blockcount := blockcount - 1;
        IF blockcount < 1 THEN
           BEGIN
              WRITELN('Enter number of blocks to do');
              READLN(blockcount);
              IF blockcount = 0 THEN blocknr := 9999;
              IF blockcount > 20 THEN blockcount := 20
           END;

        IF blocknr < 1103 THEN transferblock

      UNTIL blocknr > 1102;

   CLOSE(theoutput, LOCK)

END.
```

(2b)

```
Enter starting block number to grab from right drive
259
Output will be to the file "A.TEXT"
Do you approve?
y
Enter number of blocks to do
5
Transferring Block #259
Transferring Block #260
Transferring Block #261
Transferring Block #262
I found END. in block #262 ■
```

BYTE's Bugs

Historical Correction

Regarding Keith S Reid-Green's article "The History of Computers: The IBM 704" (January 1979 BYTE, page 190), the magnetic core storage unit, shown in photo 1, is the IBM 737. It had a capacity of 4096 36 bit words. The 32 K core storage, referred to in the article, is the IBM 738 and did contain a minor amount of solid state logic.

The IBM 711 (photo 3) could read any of 80 card columns, selectable by a plugboard whose access is shown under the identification tag. Only 72 of those 80 columns could be read at any one time, however. Also the Q bit of the multiplier-quotient register was used in multiply to contain bits of partial product during shifts.

I am sure that all of us "old-timers" who worked on the 704 appreciate your nostaglic look backward to the early days of this industry.

Warren G Tisdale
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Raleigh NC 27612■

Commander in Chief Generalized

Regarding the program Commander in Chief, presented in December 1978 BYTE, page 192, there are several minor errors: location 093 should read (÷) instead of (−) ; and (PGM) should be inserted at location 041. To get different games each time, one need only enter any number before pressing (E) . The program can be modified in the following manner to remove the necessity of entering a new seed number for each game:

128	(LBL)
129	(LNX)
130	(RLL)
131	(9)
132	(*CM'S)
133	(STO)
134	(9)
135	(CLR)
136	(1/x)
137	(R/S)

Dennis Grundler
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Event Queue

April 3-5, Specifications of Reliable Software, Hyatt Regency Hotel, Cambridge MA. This conference is sponsored by the IEEE Computer Society. Contact Douglas T Ross, Softech Inc, 460 Totten Pond Rd, Waltham MA 02154, (617) 890-6900.

April 5-6, Computers in Ophthalmology, St Louis MO. This is a course in application of computers to ophthalmic patient care and clinical reseach. Sessions dealing with data bases, automated patient testing, artificial intelligence, and image processing are being planned. Contact Robert Greenfield, DSc, Biomedical Computer Laboratory, Washington University School of Medicine, 700 S Euclid Av, St Louis MO 63110.

April 9-11, Computer Contract Negotiation, Atlanta GA. This 3 day course is designed to give participants sound answers to the complex ramifications of preparing and negotiating computer contracts. Contract Brandon Consulting Group Inc, 505 Park Av, NY NY 10022.

April 9-11, Data Processing Operations Management, Miami FL. This seminar will emphasize the management skill and techniques applicable to the data processing operations function. The curriculum is designed toward practical, applied management techniques to provide a sounder understanding of the ways of managing data processing operations more effectively. Contact The University of Chicago, Center for Continuing Education, 1307 E 60th St, Chicago IL 60637.

April 9-12, Interface '79, McCormick Pl, Chicago IL. This is the seventh annual conference and exposition on data communications and computers. Contact The Interface Group, 160 Speen St, Framingham MA 01701.

April 16-20, Data Communication Systems and Networks, George Washington University, Washington DC. This course is designed for systems analysts, engineers, managers, and others who need a better working knowledge of data communication systems. The course will be of particular value to those who are currently planning, designing or implementing a computer that involves data communications. The objective of the course is to provide participants with an understanding of the basic principles and current techniques involved in computer to computer and terminal to computer communications and networking. Contact Continuing Engineering Education, George Washington University, Washington DC 20052.

April 18-20, Understanding and Using Computer Graphics, Dallas TX. This course is for people who are now using or making decisions about using computer graphics and its role in their organization. It will describe computer graphics; show how installing computer graphics can be justified; explain what hardware and software systems are available and give costs and performance comparisons. Contact Frost and Sullivan, 106 Fulton St, NY NY 10038.

April 23-26, Middle Eastern Electronic Communications Show and Conference, Bahrain Exhibition Ctr, Bahrain. The exhibition will consist of companies marketing communication systems, products, and services. Contact Gerry Dobson, MECOM '79, Arabian Exhibition Management, 11 Manchester Sq, London W1M 5AB.

April 23-27, PASCAL Programming for Mini and Microcomputers, Ramada Inn, Woburn MA. This course covers a general approach to the use of high level languages in small computers, including an intensive course in PASCAL programming, and an introduction to structured programming techniques. Contact Institute for Advanced Professional Studies, One Gateway Center, Newton MA 02158.

April 23-27, High Speed Computer Organization: Super Machines and Low Cost Systems, Holiday Inn, Westwood CA. For computer designers, system architects, project leaders and managers involved in the implementation, application and evaluation of high speed computing systems. The course provides a thorough understanding of the principles of high speed computer organization and their use in cost effective systems. Several commercial and paper high speed computers are presented and compared. Contact UCLA Extension, 10995 Le Conte Av, Los Angeles CA 90024.

April 24-26, Electro/79 Show and Convention, New York Coliseum and Americana Hotel. Contact William C Weber Jr, general manager, Electronic Conventions Inc, 999 N Sepulveda Blvd, El Segundo CA 90245.

April 30-May 2, First Annual International Conference on Computer Capacity Management (ICCCM), Washington DC. Individuals involved in computer capacity management will present papers on research, experiments and other activities concerned with the importance, requirements and benefits of capacity management in today's data processing environment. Contact Marken Communications, 2275 E Bayshore Rd, Palo Alto CA 94303.

May 11-13, The West Coast Computer Faire, San Francisco Civic Auditorium. This is a conference and exposition on personal computers for home, business, and industry. Contact Computer Faire, POB 1579, Palo Alto CA 94302, (415) 851-7075.

May 21-25, Systems Analysis Workshop, Chicago IL. This workshop will teach systems analysts and others needing systems analysis skills to use a practical set of tools and techniques to evaluate user requests and document requirements for new data processing systems. Contact Brandon Systems Institute, 4720 Montgomery Ln, Bethesda MD 20014.

June 6-8, Eighth Annual Conference of the MUMPS Users Group, Marriott Hotel, Atlanta GA. Papers will be presented on all aspects of MUMPS development, implementation, and use. Contact Judith Faulkner, Program Committee, Department of Psychiatry, Clinical Sciences Center, 600 Highland Av, Madison WI 53792.

June 6-8, Twelfth Annual Association of Small College Computer Users in Education Conference, Denison University, Granville OH. Sessions will include the presentation of papers and demonstrations of the educational use of microcomputers, computer textbook surveys, discussions with authors of computer texts, administrative uses of computers in small colleges, and a tutorial on microprocessors. Contact Douglas Hughes, Computer Center, Denison University, Granville OH 43055, (614) 587-0810.

June 6-8, Computer Contract Negotiation, NY NY. This 3 day course is designed to give participants sound answers to the complex ramifications of preparing and negotiating computer contracts. Contact Brandon Consulting Group Inc, 505 Park Av, NY NY 10022.

June 19-21, International Microcomputers / Minicomputers / Microprocessors '79, Palais des Expositions, Geneva Switzerland. The 1979 conference program will probe advances in systems and equipment with emphasis on practical applications and uses of minicomputers and microcomputers as well as the techniques important to their development. Contact Industrial & Scientific Conference Management Inc, 222 W Adams St, Chicago IL 60606.

June 20-22, The 1979 Symposium of the Wilmington Section of the Instrument Society of America, University of Delaware, Newark DE. The symposium theme: *Measurement Technology for the '80s* is being programmed by three of ISA's divisions: Process Measurement and Control, Analysis Instrumentation, and Water and Waste Water Industries. Contact A H Straightiff, E I Du Pont de Nemours and Co Inc, (302) 366-3810.

June 27-29, Machine Processing of Remotely Sensed Data, Purdue University, W Lafayette IN. The symposium will focus upon the theory, implementation and novel applications of machine processing of remotely sensed data. Contact Purdue University, Laboratory for Applications of Remote Sensing, 1220 Potter Dr, W Lafayette IN 47906. ■

Circle 384 on inquiry card.

Circle 180 on inquiry card.

Clubs and Newsletters

Exchange Information with Brazilian TRS-80 Group

A Brazilian TRS-80 users group is interested in starting a software and hardware experience exchange with other user groups. Contact Douglas Gilson, RUA Sambaiba #516, Leblon, Rio De Janeiro 20,000 BRAZIL.

The Cleveland Digital Group

The Cleveland Digital Group meets at 2 PM on the third Sunday of each month in the old railroad station at Safier's Inc, 8700 Harvard, Cleveland OH 44105. Write the club at the above address for more information.

The Valley Computer Club Changes Meeting Location

The Valley Computer Club of Burbank CA is no longer meeting at the Harvard School in Studio City. The club, which has 228 members, now meets at the Burbank Board of Realtors Hall, 2006 W Magnolia Blvd in Burbank. The time remains the same as the first Wednesday of each month at 7 PM. Inquiries should be sent to The Valley Computer Club, POB 6545, Burbank CA 91510.

Apple II Users Group in Denver Area

A new Apple II users group, called Apple Pi, has been formed in the Denver area. They meet at 7:30 PM the first Thursday of each month in room 271, Green Center, Colorado School of Mines campus in Golden CO. They have begun a software exchange and are planning a training, hardware and software ideas exchange as well as a newsletter. Contact Austin R Brown Jr, secretary, 407 Peery Pky, Golden CO 80401, (303) 279-5388.

Educational, Recreational Computer Club

The ERCC (Educational, Recreational Computer Club) was formed in Owosso MI in September of 1978. Meetings are scheduled monthly and usually include a speaker. A large portion of each meeting is devoted to discussion and trade of programming ideas. Plans for the future include forming a club library and possible group purchases. A newsletter is published monthly and is available for $2.50 a year to nonmembers. Contact Paul Heimnick, 1415 Olmstead St, Owosso MI 48867, (517) 723-7602.

St Louis Area Computer Club

The St Louis Area Computer Club meets at 7 PM on the first Thursday of the month at the Thornhill Branch of the St Louis County Library on Fee Fee Rd north of Olive Rd. The meetings are open to the public. Club dues are $5 which includes a newsletter. Contact SLACC, POB 28924, St Louis MO 63132.

Glitch Kickers Computer Club

The Glitch Kickers Computer Club has recently formed in Des Moines IA and is looking for new members. The club is open to anyone, whether you have a computer or are just interested in learning about computers. The club plans to work in several areas, among them education, writing software and starting a personal computer network. The club meets the first and third Saturday of each month at 2 PM. The meeting place is the Computer Emporium, 3711 Douglas, Des Moines IA. For further information, call (515) 279-8861.

Commodore PET 2001 User Group

PET User Group is an organization for people interested in the Commodore PET 2001 computer. Their purpose is to share and exchange applications, programs, and hardware expansion techniques; and to provide general user feedback. The first year membership is $5 and will include six issues of the *PET User Notes.* Write Gene Beals, POB 371, Montgomeryville PA 18936.

Delaware Club Develops Home Heater Control

Jodie Hobson, president of the Delaware Users of Microprocessor Systems, writes to tell us that his club is interested in both hardware and software and they are combining both in the development of a home heater control as a club project. The club meets the first Monday of each month at the University of Delaware. Contact Jodie at 318 B Chapel Av, Claymont DE 19703 or call (302) 792-2319.

New Mexico Computer Society

Dick Franzen, president of the NMCS (New Mexico Computer Society), has written to inform us of the existence of his club. NMCS promotes the understanding and use of computer technology in all areas of our society. They have a

diverse membership including high school and college students; housewives; electronic and computer technicians; and various professional and business people. Anyone interested in computers, regardless of their level of understanding or expertise, is encouraged to attend one of their meetings. The club's interest groups include: TRS-80 basic programming, TRS-80 advanced programming, TRS-80 business applications, M6800, software, personal programmable calculators, and computer technology. NMCS meets quarterly; however, each of the interest groups has its own meeting schedule which is published in their monthly newsletter, the *Bit Stream.* For more information, write or call Dick at POB 26544, Albuquerque NM 87125, (505) 292-1572.

MicroComputer Investors Association

The January 1979 issue of *The MicroComputer Investor,* the journal of the MicroComputer Investors Association, continues to reflect admirably upon the activities of the association. In this issue there are 18 articles within the journal's 214 pages. Each article deals with utilizing microcomputers to make or manage investments. The association is professional and nonprofit in nature. Dues are currently $30 per year. Membership in the association carries with it the requirement for each member to submit one article per year for publishing in the association's journal. Persons desiring to become members of the MicroComputer Investors Association should send a self-addressed stamped envelope to J Williams, 902 Anderson Dr, Fredericksburg VA 22401.

Caterpillar Computer Club

The members of the Caterpillar Computer Club are interested in home built as well as prepackaged systems to be used in home applications or civic interest applications. Some instrumentation is club owned and may be loaned out. They meet the first Thursday of each month at 7 PM in the Caterpillar Administration Building, 100 NE Adams, Peoria IL 61629. Contact Robert Miller, club president, 1539 Moss, Peoria IL 61606.

Publication for Apple II Owners

Apple Pugetsound Program Library Exchange (A.P.P.L.E.) is an association of approximately 400 members throughout the United States. Each month they publish a magazine called *Call – A.P.P.L.E.* which contains information on the Apple II's capabilities, utility, programs and general tidbits of useful facts. Volume I has been compiled into a bound edition consisting of all the articles published in 1978. For further information about obtaining the magazine or Volume I, contact *Call – A.P.P.L.E.*, 6708 39th Av SW, Seattle WA 98136.

Newsletter for Computalker CT-1 Speech Synthesizer

Computalker Consultants, manufacturers of the Computalker CT-1 speech synthesizer, have announced the first issue of *The Word from Computalker*, a user newsletter. *The Word* is a 16 page newsletter designed to open up two way communication between Computalker Consultants and users of the CT-1 speech synthesizer and other interested parties. It contains items of interest about CT-1 applications, new software, new hardware, software fixes, software written by users, technical manual updates, and more. The premier issue of *The Word* is free to all who write for a copy. Five issues will be included with the purchase of each CT-1 speech synthesizer. Additional copies of *The Word* will cost 60¢ each and may be obtained by writing to the company at 1730 21st St, Suite A, Santa Monica CA 90404.

Attention: Phoenix AZ Computer Users

A new computer club is forming in the metropolitan Phoenix area. For more information, call or write Marc Tessler, 3520 W Dunlap Av, #106, Phoenix AZ 85021, (602) 249-6224.

Attention: Long Island Computer Enthusiasts

Aileen Harrison, treasurer and secretary of the Long Island Computer Association, has written us that the club meets at 8 PM on the third Friday of the month at New York Institute of Technology, Route 25A, Old Westbury NY, building 500, room 508. One hour before the regular meeting the 6800 users group meets at the same location and every second Friday of the month the 8080 user group meets. The club is entering its fourth year and has approximately 140 members. The meetings consist of various programs such as "show and tell," tutorials, hardware lectures, language lectures, group discussions by members, computer manufacturer presentations, and presentations by computer stores describing the products they market. The dues are $10 per year and every paid member gets a free raffle chance each month on some "goodie." Also paid members are entitled to borrow USCD Pascal disks and users manual on a monthly first come first serve basis. Members receive a copy of the monthly meeting notice. For more information, contact Aileen at 36 Irene Lane E, Plainview NY 11803.■

Circle 280 on inquiry card.

Continued from page 8:

1802 QUEST FOR INFORMATION

Hey, how about some support for the poor little 1802? It is no longer an obscure processor used by few of us. Many personal computers utilize this chip—the RCA VIP, Quest Super Elf, Netronics Elf II, many homebrew systems, and others. An 1802 recently went up in an OSCAR satellite! Much software is available to 1802 users, including debug and monitor routines, video games, Tiny BASIC, and general purpose programs available from the many 1802 based clubs.

Writing one's own software is simple, due to the unique COSMAC architecture. The processor contains sixteen 16 bit general purpose registers that can be used to hold data and memory addresses to point to stacks, subroutines, etc. The program counter can be changed to any one of these under program control, facilitating the use of subroutines.

What about hardware? The 1802 is completely static and CMOS, resulting in very low power dissipation, an important consideration when designing battery operated systems. It is available in two voltage versions: 4 to 6 V and 4 to 12 V. There is also an on chip direct memory access controller that simplifies loading of programmable memory, since this can be done in hardware without the need for a bootstrap read only memory. Memory interface is simple and straightforward, because no bizarre data multiplexing is performed; sequential high and low order bytes of the memory address are strobed onto an 8 bit bus by two timing pulses. Once decoded, the address is used just as any other 16 bit address bus. Hardware single step is also easily implemented . I/O (input/output) is especially simple, due to three binary encoded output lines that can be controlled by the processor to select one of eight input and output devices directly. Also available are four flag lines that can be tested by the processor to determine a course of action. These features, coupled with the simple 93 instruction set and RCA support chips make software and hardware development painless (and sometimes even fun).

We avid 1802 fans are no longer a tiny minority, and would like some support from BYTE, a magazine that many of us subscribe to for the purpose of discovering the latest in the computer world. The 6800 and 8080A are good processors, but there *are others* on the market.

In addition, please go a little heavier on hardware. Also, I would like to see an article on the *very basics* (no pun intended!) of Pascal. I've read and reread the previous pieces, but I still can't make heads nor tails out of a Pascal listing.

Other than these few gripes, I enjoy your magazine, and look forward to its arrival every month.

Ivan Dzombak
621 Spring St
Latrobe PA 15650

[*Authors take note! Our articles come from our readers. Let's see some more information on the 1802—*RGAC.]

CANCELLED AND HAPPY?

Recently I took advantage of your offer to receive one free issue of BYTE by filing for a subscription and canceling after receiving the first issue.

Although I did cancel the subscription upon receiving the first free issue, I do wish to compliment you on the quality of BYTE. I canceled not because I did not think BYTE to be a good buy for the computer hobbyist, but because it made it clear to me just how big the hobby is! As an active amateur radio operator in the process of designing and building some new major pieces of hardware, I decided that I had better get more of that work out of the way before I delve into computers too deeply.

I expect to return to BYTE in about a year or so—a short time before I begin any extensive home computer experimentation. That first issue of BYTE has convinced me that it will provide the means for coming up to speed on the subject.

Richard A Griffiths
6510 Foster St
District Heights MD 20028

A BASE COMMENT

I enjoyed Harold Pritchard's tip on using an ordinary calculator for addition and subtraction of hexadecimal numbers (January 1979 BYTE, page 165). Your readers might be interested to know that this technique works for all number bases from 2 through 99. To use for other bases, all you need do is find the number to add or subtract for carrys and borrows. The "magic number" is simply 100 minus the base being used. For hexadecimal it's 100 - 16 = 84 as we've seen. For octal it's 100 - 8 = 92, and for binary, 100 - 2 = 98. As with hexadecimal, four digits is the most you can work with using an 8 digit calculator.

David L Johnson
4106 Montreal Av
Prince George, VA 23875

COPYRIGHT INFORMATION GATHERING

I'm becoming more and more interested in the question of software copyrights. I'm sure the editors at BYTE agree that this is a subject which is confusing to anybody who starts talking about it; there are no legal precedents, nobody really knows how to

define the dividing line between expected use of published software and theft.

I'm polling editors and the major computing magazines, hoping they will help me define some of these issues. I'd appreciate getting your views on this thorny subject. Besides being editor of *Dr Dobb's Journal,* I'm getting a master's degree at Stanford in journalism—this quarter I'm taking a course in the law school entitled "Communications Law." I will be talking (and in fact, am already talking) with lawyers and legal scholars on this subject—frankly, they're more confused than anybody else. One consensus among the legal people I've talked to is this: the dividing line between expected use and theft is money.

When you publish software, what do you expect will happen to it? An interested computerist will adopt or adapt the program for his or her own use? A club will play around with it? Another magazine—nonprofit, for instance like mine—will reprint it? When do your hackles rise over use of software originally printed in your magazine? When does it become unfair?

What I want to do is gather comments from people like you and combine them with advice and facts from legal scholars. After which, I will write an article attempting to pull this data together and make sense of it. Hopefully, the article will be the first of many others in which people in the field will try to arrive at some working conclusions.

I look forward to hearing from you.

Suzanne Rodriguez
Dr Dobb's Journal
POB E
1263 El Camino Real
Menlo Park CA 94025

When we publish software, it is subject to copyright, the only meaningful form of protection. Just as we would expect someone to formally ask for permission to reprint an article published in BYTE magazine, we would expect similar respect from anyone going beyond the bounds of fair use with respect to program copies taken from our products. In short, when we publish a program with copyright protection, whether as part of a book or as part of an article, we would expect anyone copying and distributing such a program to write requesting permission to do so. We are not averse to giving permissions with credit, and no publisher with a long-term view would, in my opinion, have a blanket policy against granting such permissions.

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As for software publishing, when we buy a program for reproduction in book form, or as a simple listing plus documentation (often accompanied by machine readable code), we treat it in the same way as we treat the ideas of an author writing a conventional article or book. We are buying the embodiment of those ideas in a particular written or program form, not the ideas or concepts which constitute the program or work of writing. Because of the rampant confusion in the software area, our typical contract with authors of software explicitly states that we are buying an exclusive license to the software reproductions in book form, with the rights to license the software in other ways to manufacturers or media distributors retained by the author. The act of sale of the book or listing copy is then, in our view, totally analogous to the act of sale of such items as a phonograph recording, a book about some subject, a video recording, or other relatively conventional published work. This act of sale carries with it an implied zone of fair use reproduction possibilities, but is in no way a license to widespread reproduction whether it is done commercially or by some "nonprofit" entity.

*Basically, there should be a software publishing analogue of the ASCAP or BMI organizations of the music world, but the field is too young at present. There are a number of questions to be answered as history unfolds in this field but, contrary to your letter's viewpoint, there are historical precedents which can certainly be examined and applied to the new concept of computer programs as works of authorship and original composition. . . .*CH

IBM Emulation Information Needed

As an avid BYTE reader, I have, as a last resort, turned to you to request some assistance. I am looking for a software house that can supply the communications software for effecting IBM 3780 and Teletype emulation using a standard mini/micro system. There are a number of manufacturers (ADDS, Datapoint, SYCOR) who have such emulators available when one purchases or leases their equipment; however, I do not wish to be tied down to any one manufacturer. The software is proprietary and cannot be used on the standard systems. Can you supply any leads in this area?

George J Lehmann
Data Processing Consultant
163 S Sycamore Av
Hollywood CA 90036

THE SHAPE OF LIFE

I liked the articles on Life in the December 1978 BYTE.

An area of Life that I find particularly fascinating is the behavior of Life forms in universes other than the flat two-dimensional universe. For example, in cylindrical or torus shaped universes it is possible for various kinds of stable "shock waves" to exist. These consist of complete loops around the universe and travel at the velocity of light, or twice as fast as a space ship. The simplest forms look like combs and can leave various kinds of debris behind or simply empty space. Another class of objects not found in the flat universes are "universal oscillators" that can exist in finite universes of the torus type and which engulf the entire universe.

To investigate these kinds of Life forms I wrote a program in COSMAC 1802 machine language that runs on the RCA VIP Computer. The geometry of the universe can be selected by the user. Speed is very desirable if you are trying to determine the fate of a particular pattern and I spent considerable effort to maximize the program speed. The program calculates about five generations per second for an almost full universe up to 25 generations per second for an almost empty one. The actual speed can be set to a lower value by the user and this is useful for examining a pattern in detail or for designing new patterns.

To make the program generally useful I added pattern storage and pattern editing features. Those readers who are interested in obtaining copies of the program can write to ARESCO, POB 43, Audubon PA 19407.

Brian Astle
22 Fieldston Rd
Princeton NJ 08540

KUDOS

After reading so many complaints (and suffering from the same problem myself) about vendors of computer peripherals, I'd like to salute one of the "good guys" of the industry. We're always quick to condemn, but how many of us take the time to give praise when someone's worked hard to earn it???

I nominate for "The Good Guy of the Month Award" Warren Rosenkrantz, superstar of V R Data Corporation in Folcroft PA. After dealing with several other rather questionable firms, I received a flyer from V R Data congratulating me on the purchase of my Radio Shack TRS-80 and listing several peripherals at very attractive prices. I investigated and, to make a long story short, began what I hope to be a long and rewarding business relationship.

Warren and his staff exhibited a willingness to help a fledgling computerist. They brought back that old, forgotten trait that makes good businessmen great—the customer comes first. Sure, like everyone else in this mad industry, we had problems such as printer modifications that didn't work and the disk drive that gave weird results. However, Mr Rosenkrantz spent considerable time and effort to correct these problems and, together, I think we both learned a lot. He's also very knowledgeable in the field of electronics and is quickly becoming a pro on the TRS-80. What do you expect from a guy who starts work at 5:30 AM and sometimes doesn't quit until after 10 PM?

I reiterate that praise is something earned—and Warren Rosenkrantz of V R Data Corporation has certainly earned praise from this very satisfied customer.

Clifford W Coughlin
30 S Kirklyn Av
Upper Darby PA 19082

"THUS & SO" IMPLEMENTATION

In the December 1978 BYTE Carl Helmers, comparing BASIC to Pascal, made the point that:

> *In BASIC I would have to reference [a procedure] in the program with a number artificially created for that purpose. I might say GOSUB 10000, for example, when I really mean to call and execute a thus-and-so procedure.*

Good point! Because of this lack of expressiveness in ordinary BASIC the Canon model BX-1 allows statements such as GOSUB "Thus&so". Elsewhere in the program the same alphanumeric literal appears as a label, identified as such by the keyword FLAG. Note that, due to using quotes, it is possible to use upper and lower case, special characters, spaces and even graphic characters. It is not necessary to begin with a letter or to avoid keywords of the language. The BX-1 does, however, limit the length of the label to eight characters.

GOTO may be used in the same way. Furthermore, the BX-1 executes statements such as ON A$ GOTO "YES", "NO", "MAYBE", "HELP!". If A$ matches any of the literal strings shown, then a branch to the location so labeled will occur. If there is no match, execution continues with the next statement. The statement form except with GOSUB is also in the BX-1 language.

As far as I am aware, the observation of Mr Helmers is correct for all other BASIC implementations.

Craig Busse
Canon USA, INC
140 Industrial Dr
Elmhurst, IL 60126 ■

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PET WORD PROCESSOR



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WE EXPORT
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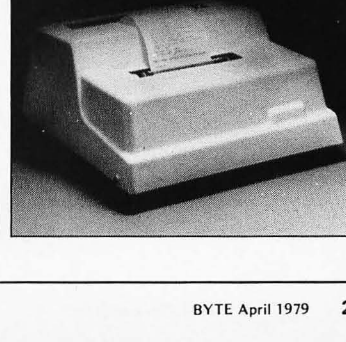
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mpi

Circle 265 on inquiry card.

An Introduction to Microprogramming

Ben E Cline
702 Southgate Dr
Blacksburg VA 24060

Many computer users have not been exposed to the subject of microprogramming although it was introduced more than 25 years ago. With the advent of microprogrammed microprocessors, though, more and more people are gaining access to the world of microprogramming. The purpose of this article is to provide an introduction to the subject.

The word *microprogramming* was introduced in 1951 by M V Wilkes to describe a method of implementing the control circuits of a digital computer that differed from the conventional hardwired logic approach. The actions of a microprogrammed processor during the execution of an instruction are determined by a program in high speed memory called the control store. The data paths, memory units, and arithmetic and logic circuits of the processor are directly controlled by bits in a microinstruction held in the control store. Each machine instruction results in the execution of one or more microinstructions.

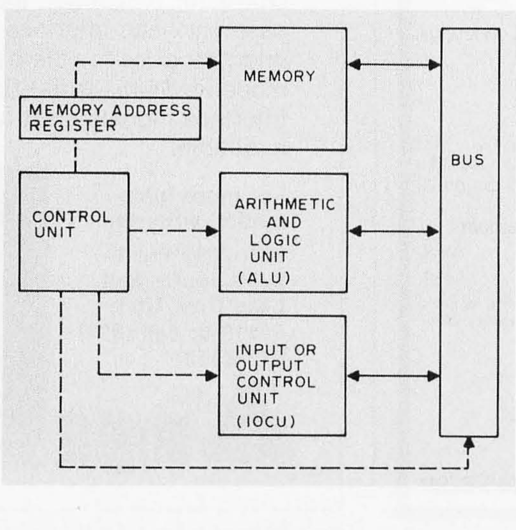


Figure 1: Functional block diagram of a conventional bus structured computer. Solid lines indicate data paths and broken lines indicate control lines.

Conventional versus Microprogrammable Architectures

Figure 1 is a functional block diagram of a conventional bus structured computer. The memory unit is used to hold both data and machine instructions. The arithmetic and logic unit (ALU) performs arithmetic and logic functions such as addition, logical AND, etc. The input and output (IO) control unit communicates with the external world. Data is passed between memory and the arithmetic and logic unit by a bus system. The IO, arithmetic and logic unit, memory, and bus circuits are controlled by hardwired logic to generate the necessary signals to fetch, decode and execute machine instructions.

A microprogrammed architecture is presented in figure 2. This functional diagram is similar to figure 1 except for the control unit. The conventional control unit has been replaced with a programmable control unit. Each step of the machine level instruction fetch and each step of a machine instruction execution is controlled by a microinstruction. The microinstructions are held in the control store. The control store is a high-speed memory which is usually independent of main memory. The address control unit determines which microinstruction will be fetched and executed next. Several addressing methods are discussed later in this article. The microinstruction register (MIR) holds the current microinstruction being executed. The microinstruction in the register is decoded by the decode logic which generates signals to control IO, arithmetic and logic unit, memory and bus according to the actions specified in the microinstruction.

The decode and address control circuits of the microprogrammable architecture are

much simpler than the control circuits used to implement the full instruction set of the conventional machine. However, the simplicity of the elementary hardwired microcontroller is partially offset by the addition of a new element: the control store. A significant part of the cost of a microprogrammed computer also lies in the set of *microprograms* which must be developed and debugged to simulate a full virtual machine instruction set. As a result, the costs of the two types of computer architecture are probably comparable.

The microprogrammable central processor is often referred to as the *host* machine because many different *virtual* machines can be superimposed on it by changing the control store. By implementing different microprograms in the control store the hardware seems to change from the viewpoint of the virtual machine software. For this reason, a microprogrammable computer is said to *emulate* the architecture of a particular virtual machine.

This emulation technique is a powerful tool. It enables the same basic hardware to implement the instruction sets of many different computers. For the homebrew computer builder who goes this route, a basic 8 bit microprogrammed machine acting as the host might be programmed to emulate any one of the existing 8 bit microprocessors. The same host machine might even be used to emulate an IBM 370 so that some widely available public domain software could be utilized. Potential microprogrammers should be warned, however, that creating the microprogram for such an emulation is not a trivial undertaking.

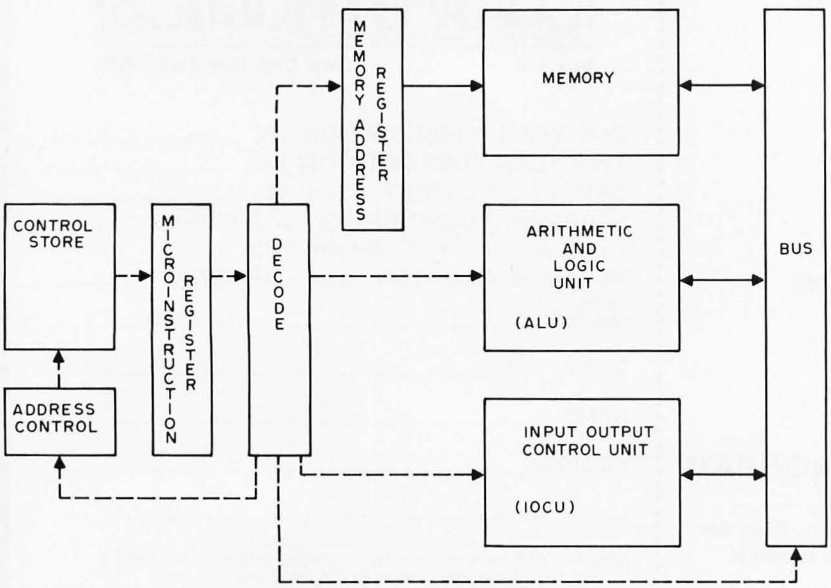


Figure 2: Functional block diagram of a microprogrammed bus structured computer. Solid lines indicate data paths and broken lines are used to indicate control lines.

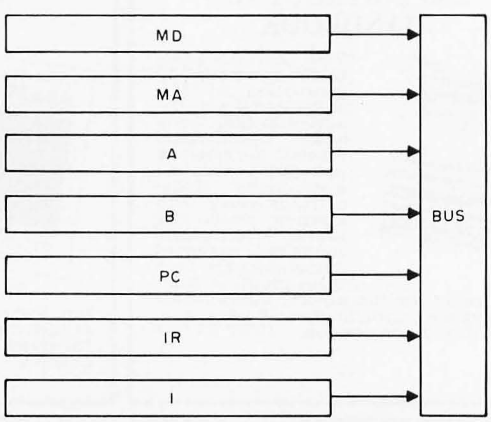


Figure 3: Input side of a typical bus in a hypothetical computer. The register names (MD, MA, etc) are not important and serve only as labels for this example.

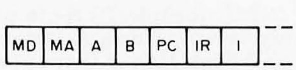


Figure 4: Portion of a horizontal microinstruction to control the connection of registers to the bus in figure 3. Each box is a microinstruction bit that enables the indicated register-to-bus connection.

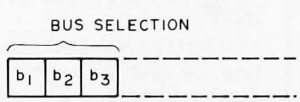


Figure 5: Portion of a vertical microinstruction to control the connection of registers to the bus in figure 3. Here, three bits are used to encode a choice between seven registers or a 0 "no operation."

Microinstruction Formats

There are two microinstruction formats: *horizontal* and *vertical*. Most machines use a combination of these two. In a horizontal system, each bit in the microinstruction controls one data path or function in the machine. Figure 3 shows the input side of one bus in a hypothetical machine containing several registers. The A, B, MA, MD, PC, IR and I registers may be logically switched onto this bus, which might then route the data to one input of the arithmetic and logic unit.

Figure 4 shows a portion of a possible horizontal microinstruction format to control the data paths of figure 3. Seven bits are reserved in each microinstruction to indicate which, if any, registers are to be switched onto the bus. If all these bits are 0, no data is put on the bus and the bus carries a value of 0. If any of the seven bits of the current microinstruction is 1, the corresponding register is put on the bus. To avoid conflicts, only one bit position in the 7 bit bus field may be logical 1 at any given time. Depending on the electronics of the bus structure, switching more than one register onto the bus at the same time may damage the hardware or simply give unpredictable results.

A vertical microinstruction format groups similar functions into operation codes called *micro-orders*. A micro-order for the bus input of figure 3 is given in figure 5. Since only one binary code can exist in the 3 bit field, it is not possible to put more than one register on the bus at a time. The vertical microinstruction format is more compact than a corresponding horizontal format.

Each microinstruction typically contains bits to control all computer functions. In a microinstruction, the two inputs of the arithmetic and logic unit and the destination of the output would be specified. The main memory read and write functions are specified by microinstruction bits. Bits for testing register quantities are also provided along with bits to cause jumps and subroutine calls in the microprogram. "No operation" may be specified if a particular bus or function is not used for a microprogram step.

Control Store Addressing

The control store is much like a conventional memory. In cases of machines where user microprogramming is not allowed, a read only memory is used to contain the standard virtual machine instruction set. If the manufacturer supplies microinstructions to emulate more than one machine, or if user microprogramming is allowed, a programmable memory called a *writable control store* is used. If users are allowed to add instructions but not alter the basic instruction set, part of control store will be read only memory for the basic instruction set and part will be writable control store for additional instructions.

Homebrew computer people who choose to do microprogramming will most likely implement a writable control store and hardware to load it. Another alternative is to use inexpensive high-speed programmable read only memory to store microinstructions.

One control store addressing technique often used is to execute microinstructions in sequence. This technique is typically used with the vertical microprogramming format. A microinstruction counter, which is similar to a program counter or instruction counter in a virtual machine environment, is used to step through the microprogram. A microinstruction may contain a jump command which is indicated by a certain bit pattern in one of the micro-orders. With this technique the jump address is contained in the microinstruction in place of certain other micro-orders; thus, not all operations can be specified in a microinstruction that specifies a jump function.

Another addressing technique uses a field in each microinstruction to specify the address of the next microinstruction to be executed. Horizontal microcoding formats typically use this technique. This method requires additional bits in each microinstruction that the sequencing method does not need.

Executing Virtual Machine Instructions

Executing a virtual machine instruction typically begins with the microprogrammed instruction fetch. The instruction fetch is performed by a microprogram routine which sends the virtual machine program counter contents to a memory address register, cycles memory and puts the instruction which comes back from memory into the instruction register (IR). This instruction has a virtual machine op code which indicates which operation should be performed. To emulate the instruction, the proper microprogram in control store must be selected and executed. For example, if the op code 4 means ADD and the ADD microprogram begins in control store location 100, the next microinstruction fetched after loading the ADD instruction into the instruction register should be fetched from location 100.

One method of providing the proper mapping between op code and control store address is by an indirect jump through the instruction register op code field. When the op code indirect jump is specified (by a specific bit pattern in the current microinstruction), normal control store addressing is suspended and the op code gives the address of the next microinstruction to be fetched and executed. If a 4 bit op code is used, an op code indirect jump would cause the next microinstruction to be fetched from a control store location from 0 thru 15, depending on the op code value. The first 16 locations of the control store would contain jump instructions to the microprograms for each of the 16 op codes. If the ADD instruction is op code 4 and the ADD microprogram is at location 100, control store location 4 would contain a microinstruction specifying a jump to location 100 (see figure 6).

A second method for relating op codes to microprograms is the use of a read only memory mapper. A special read only memory contains the beginning address of microprograms which emulate each virtual machine instruction. When the mapper is invoked, the op code in the instruction register is used to address the read only memory which looks up the proper address of the microprogram to emulate the virtual machine instruction indicated by the op code (see figure 7).

This method is used in such machines as the HP 2100 minicomputer. A memory mapper is not flexible enough to be used in a computer where the virtual machine instruction set is altered dynamically. To change the virtual machine instruction set easily, a new mapper must be invoked. The read only

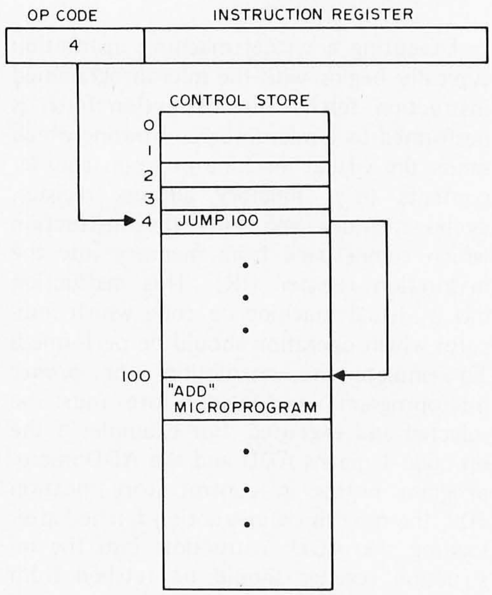


Figure 6: Mapping an op code into a microprogram routine by means of a table of indirect jumps. Here the op code 4 picks the fifth jump in the table, causing the microprogram to execute the ADD routine.

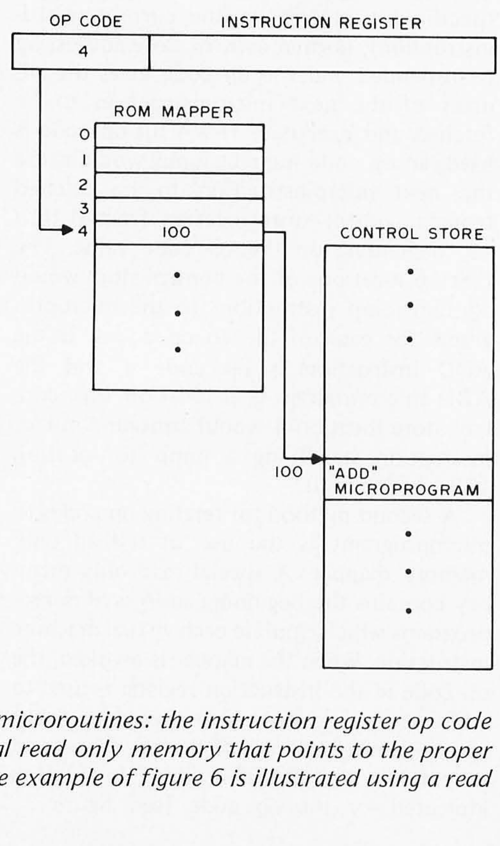


Figure 7: Another way to map microroutines: the instruction register op code field is used to address a special read only memory that points to the proper microprogram routine. Here the example of figure 6 is illustrated using a read only memory mapper.

memory mapper is most useful for manufacturers who supply a fixed set of microprograms that emulate only one virtual machine.

In both mapping techniques, a table of beginning addresses of microprograms is kept – one in control store and one in an independent read only memory. These tables are referred to as *jump tables.*

Hybrid Systems

Some of the flexibility of a microprogrammed processor is lost when certain functions are not controlled entirely by microinstructions. For example, input/output on the HP 2100 minicomputer is handled in hardware and merely initiated and synchronized by microcode. As more control functions are performed in hardware and the ability to use different instruction formats is hampered, the number of different virtual machine instruction sets that can be easily emulated decreases. On the other hand, if certain control functions are handled by hardware and the machine level instruction format is relatively fixed, a virtual machine instruction set may be emulated efficiently.

The hybrid combination of microprogramming with some custom hardware is used in most general purpose computers. Functions which cannot be handled easily in microcode, such as isolating specific instruction register bits, are delegated to hardware. The flexibility of microcode is still available for instruction sets that take advantage of the hardware functions.

Advantages and Disadvantages

There are several advantages to a microprogrammable architecture. For computer designers, the choice of the virtual machine instruction set may be postponed longer than with a conventional architecture, allowing hardware and software design to overlap and influence each other. Instructions may be added after the computer has been designed, built and marketed. As examples of this, the HP 2100 minicomputer's floating point option is implemented entirely in microcode, and the DEC LSI-11 floating point feature is achieved by plugging in an extra control store read only memory.

It is also possible with a microprogrammed machine to market a line of computers with similar instruction sets even though the actual hardware of less expensive machines may be very different from the more complex models. The IBM 360 computer uses 32 bit words and 16 general purpose registers. Some of the smaller IBM 360s have less than 16 registers and 32 bit data paths but are

microprogrammed to appear like full-sized 360s. Such microcoded versions are, of course, slower than the more expensive models.

Some manufacturers allow the user to add special instructions to their machine by use of microprogramming. Functions or portions of routines that are executed frequently in the user's system are good candidates for implementation in microcode. Microcode routines run faster than similar routines executed in main memory.

One disadvantage of allowing user microprogramming is the possibility of altering the standard instruction set. This could eliminate compatibility with other machines of the same model and decrease the reliability of a system's software. Since manufacturers sell both hardware and software, user microprogramming is usually not provided because of the compatibility factor. The design of microprogramming by the user seems presently limited to special applications and people who design their own computers from the ground up.

Studying Microprogramming

Studying the microprogramming users manual for one or more user microprogrammable machines will provide much information about microprogramming. Another source (although heavy reading) of information is a copy of IBM's patents on the system 360. If a microprogrammable machine is available, writing some simple microprograms will provide a lot of insight. If no microprogrammable machine is available, the microprogrammable architecture of a real or hypothetical machine can be simulated on a conventional machine. A simulator usually will not provide insight into the hardware timing problems that can be encountered on a real machine, but it can be used to try out microcoding ideas.

It is possible that a microprocessor system could be converted to support user microprogramming. The National IMP-16 and Raytheon RP-16 both use read only memory to control bit-sliced register and arithmetic and logic units. It is possible that a programmable read only memory or a writable control store could be substituted for the standard read only memory if timing problems could be overcome and if the control logic in the standard read only memory circuits can be simulated.

Another possibility is the use of a transistor-transistor logic (TTL) bipolar microcontroller integrated circuit. This chip is typically a 4 bit slice in some microprogrammed central processor's data paths. Putting four 4 bit microcontrollers together

with a control store and address control logic implements the central processor of a 16 bit computer. This technique is being used for the next generation of high performance minicomputers and is a plausible way for the homebrew computer designer to implement a microcoded machine.

Although this type of project would allow more people to work with microprogramming, it seems to be a sizable engineering problem. Is anyone interested?

Conclusion

Microprogramming offers something for both hardware and software proponents. The software fan can approach microprogramming from the programming viewpoint. Since the microprograms in control store must be efficient for the machine to run quickly, the design and programming of microcode is a challenging activity. Microassemblers and microcode editing and debugging programs should also appeal to the software person. The design and implementation of a microprogrammed machine should similarly interest the hardware enthusiast. A microprogrammable machine that resembles a new design may be used to test, at least partially, a new hardware design. Microprogramming should interest and challenge many computer experimenters.■

REFERENCES

1. Chu, Yaohan, *Computer Organization and Microprogramming,* Prentice-Hall, Englewood Cliffs NJ, 1972.
2. Husson, Samir S, *Microprogramming Principles and Practices,* Prentice-Hall, Englewood Cliffs NJ, 1970.
3. *Microprogramming Guide* (for Hewlett-Packard Model 2100 Computer), Hewlett-Packard Co, Cupertino CA, 1972.
4. Rosin, Robert F, "Contemporary Concepts of Microprogramming and Emulation," *Computing Surveys*, volume 1, number 4, December 1969, pages 197 thru 212.
5. Wilkes, M V, "The Growth of Interest in Microprogramming – A Literature Survey," *Computing Surveys,* volume 1, number 3, pages 139 thru 145.

Editor's Note: *BYTE is looking for more articles on the subject of homebrew computers with microprogrammed instruction sets. This is one of the most advanced state of the art techniques in computer science, yet it should be possible for individuals and clubs to do significant work in this area. . . .*CH

A Digital Alphanumeric Display

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The demand for microprocessors for personal use is growing phenomenally. If these personal computers are to be more than fancy desk calculators, however, they need to be able to receive and display letters of the alphabet as well as numbers. While there are numerous terminals on the market that make such communications possible, they are so expensive that a complete computer system is still prohibitively priced. How can the costs of inputting and outputting alphabetical characters be reduced?

Getting letters into a computer is relatively easy. There are lots of surplus keyboards around which can do this for a reasonable cost. The hard part is getting the computer to answer back in a readable form that isn't just a string of digits. Television displays will do the job, if you have a spare television; but there is another way that will permit you to build a terminal without a television, a way which may even provide you with an alphanumeric terminal little larger than a pocket calculator. The secret is to use the same digital displays that desk calculators use.

Editor's Note:

*Although prices have been significantly reduced since this article was written in 1976, the ideas presented are still quite valid. The learning experience involved with designing and building any type of interface is invaluable. . . .*RGAC

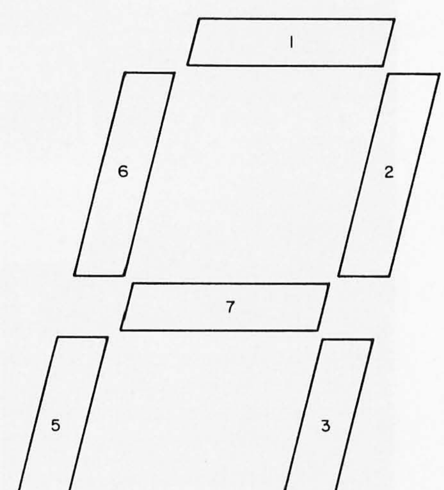


Figure 1: Labelled 7 segment digital display.

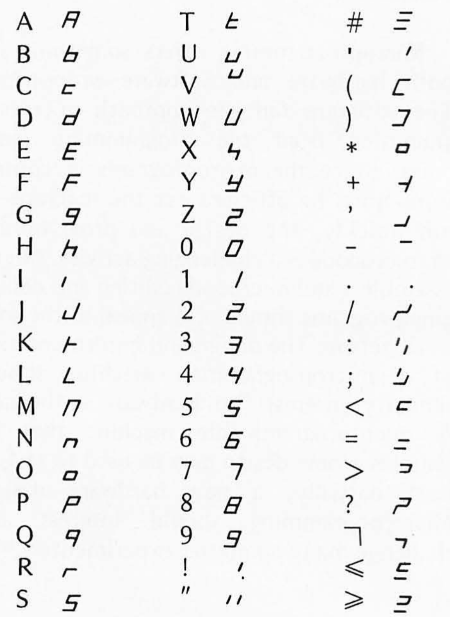


Table 1: Alphanumeric characters and corresponding output from the 7 segment digital display.

A digital display consists of a decimal point and seven line segments. If the decimal point and line segments are numbered as shown in figure 1, each display pattern represents eight bits of information. Only 21 of the 256 possible patterns are used by calculators. After a few hours of experimenting, I found, surprisingly, that most letters of the alphabet are included among the remaining 235 patterns. Although far from ideal, it is possible to display a large, recognizable character set on 7 segment digital readouts. The character set that I came up with is shown in table 1. One of the shortcomings of this set is that some letters are upper case and others are lower case. This inconvenience is unavoidable, except for a few letters like C, G, and U. Some letters, like K and X, are impossible to display others, like M, V and W, are just difficult. For these letters, and the other symbols in the character set, I chose patterns that are in some sense "close" to the desired

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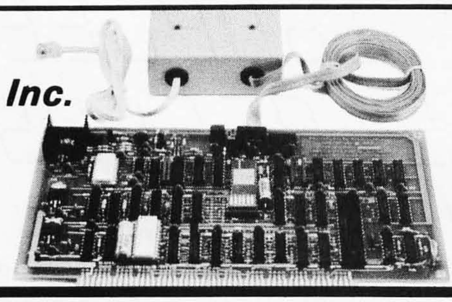
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Figure 2: Sample message written in 7 segment display code.

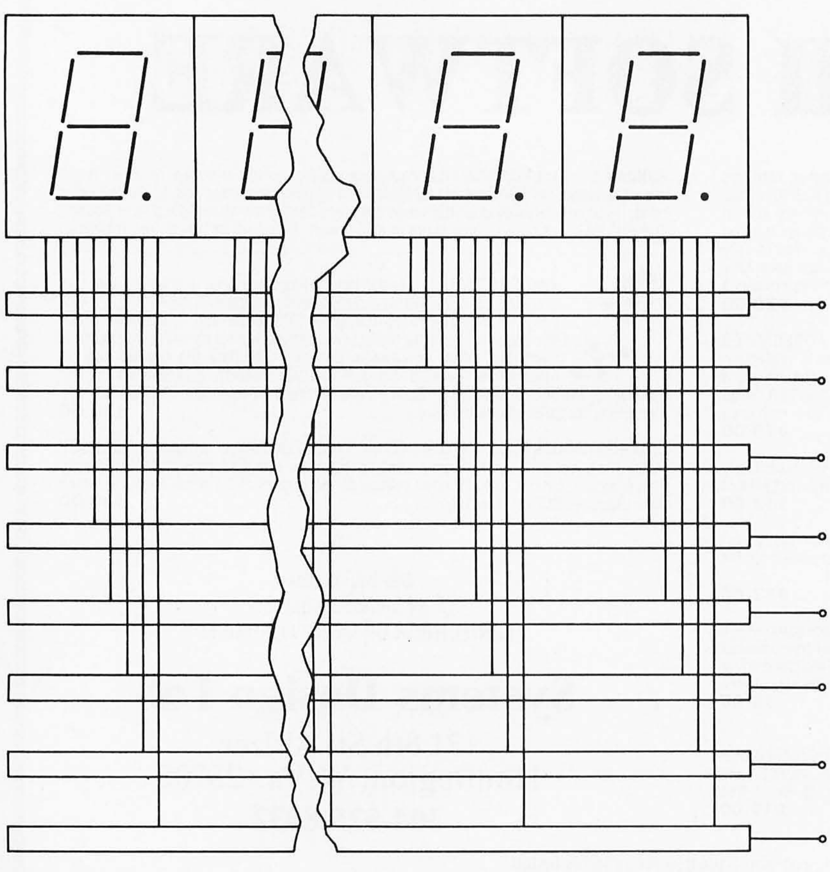


Figure 3: Block diagram of an alphanumeric display panel.

ones. Even with these imperfections, however, this display code is quite readable, as is shown by the sentences in figure 2.

A simple 8 character alphanumeric display panel can be made from eight single digit readouts and eight shift registers. Each shift register corresponds to a different line segment in the digital displays. All the bits in register 1 are connected in parallel to segment one in each of the readouts, and the other registers are connected in similar fashion to the other segments as shown in figure 3. When an 8 bit pattern is fed into the registers via their left shift inputs and the registers are shifted, the appropriate display character appears on the rightmost readout. As more characters are entered in this way, they progress, ticker tape fashion, across the display panel until they disappear at the left end of the display. To make this display panel compatible with other computers besides your own, you can use a 256 word by 8 bit read only memory to convert from ASCII code to the display code required by this panel. To extend the panel, just add more readouts and more shift registers so as to extend the original eight registers.

The most practical form of alphanumeric input is the ASCII encoded keyboard, but the digital display code makes possible a computer terminal the size of a pocket calculator. Alphabetical characters could be entered by drawing them with a stylus on a pattern of eight metal sensing areas arranged as shown in figure 1. A small number of digital readouts would display the output.■

BYTE's Bits

Call for Papers: Third International Conference on Computer Software and Applications

Papers are being solicited for the Third International Conference on Computer Software and Applications (COMPSAC 79). Sponsored by the IEEE Computer Society, COMPSAC 79 will bring together computer practitioners, users, and researchers to share their ideas, experiences, and requirements for applications software, management techniques, and software development support, including automated techniques. The conference will be held November 5 thru 8 at the Palmer House, Chicago IL. Some of the areas where papers are invited include: software development methodology, software management, database management systems, data communication and computer networking, computers and biomedicine, business office automation, industrial and design automation, application oriented languages, software testing and tools, and legal implication of electronic data processing technology. Papers should range in length between 1000 and 5000 words. The submission deadline is June 1, 1979. For additional information, contact Dr William Smith, executive director, Toll Electronic Switching and Operator Services Division, Bell Laboratories, Naperville IL 60540.■

Call for Papers: Twelfth Annual Microprogramming Workshop

The Twelfth Annual Microprogramming Workshop to be held November 18 thru 21, 1979 at the Hershey Motor Lodge Convention Center, Hershey PA will provide a forum for practical and theoetical aspects of firmware and related areas. Authors in industry and academia are encouraged to submit papers for formal presentation. Topics for consideration at the workshop include, but are not limited to: directly executable (intermediate) languages; language oriented architectures; emulation; microprogrammable host machines; on chip microprogramming; microprogramming experience; microprogramming languages; firmware development methodology; support tools for microprogramming; database support; operating systems and security kernel support; and signal processing. Formal sessions will be enhanced by informal discùssions in a workshop atmosphere. Papers should be submitted in triplicate by June 1, 1979 to Richard A Belgard, MICRO-12 program chairman, Data General Corp, 62 Alexander Dr, Research Triangle Park NC 27709.■



Programming Quickies

Label and File Program

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I occasionally need to order a part that I cannot obtain at my local vendor. Thus, I wrote a parts order program for this purpose on my SwTPC computer. The program generates two letters and two address labels. I keep one letter for my file.

Lines 8 and 2100 erase the screen and place the cursor in the upper left hand portion of my CT-1024 terminal. The program starts off by asking if a vendor's name and address is needed. If not, the program jumps to the *letter form* at line 2100. The user keys in the information prompted by lines 2110 thru 2245. If only one line is needed for parts, a carriage return may be entered when prompted for the second part (lines 2220 thru 2245).

If an address is required, the user is prompted to enter the first letter in the manufacturer's name. The letter B will list lines 250 thru 278 on the PR-40 (Bell and Howell) printer. The command LIST #7 on lines 50 thru 110 lists the lines noted on the number 7 output device. In this case, the output device is the printer. Lines 200 thru 2000 are reserved for vendor's names and addresses. They may be changed to suit the user's requirements. Lines 50 thru 150 select the various sections of the address file.

Listing 1: Parts order program written for the SwTPC 6800 computer.

```
0008    PRINT CHR$(16); CHR$(22)
0010    PRINT "'PARTS ORDER'"
0012    INPUT "NEED AN ADDRESS (Y/N)",B$
0015    IF B$="N" GOTO 2100
0020    PRINT "FILES ARE LISTED A-Z"
0030    INPUT "WHICH FILE ARE YOU
 SEARCHING FOR",A$
0050    IF A$="A" LIST #7, 200,248
0060    IF A$="B" LIST #7, 250,278
0065    IF A$="C" LIST #7, 280,298
0070    IF A$="D" LIST #7, 300,318
0080    IF A$="G" LIST #7, 350,378
0100    IF A$="L" LIST #7, 450,498
```

```
0110   IF A$="M" LIST #7, 500,610
0155   PRINT
0160   GOTO 2100
0200      ADMIRAL DISTRIBUTOR
0202      DIXIE APPLIANCE CO.
0204      BOX 12766
0206      ROANOKE, VA. 24028
0208      ---------------------
0250      BELL & HOWELL DISTRIBUTOR
0252      BELL & HOWELL CO.
0254      GENERAL SERVICES
0256      7100 MCCORMICK ROAD
0258      CHICAGO, ILL. 60645
0260      ---------------------
0280   CONCORD DISTRIBUTOR
0281   STEREO LAB II, INC.
0282   2350 MIDDLE COUNTRY RD.
0283   CENTEREACH, NY 11720
0284   ------------------------
0300      DELCO DISTRIBUTOR
0302      MOLLEN BROS. AUTO
0304      2727 W. BROAD ST.
0306      RICHMOND, VA.
2100   PRINT CHR$(16); CHR$(22)
2105   PRINT #7,
2107   PRINT "'LETTER FORM'"
2108   PRINT
2110   INPUT "COMPANY NAME",A$,L$
2130   INPUT "ADDRESS",B$,M$
2150   INPUT "CITY & STATE",C$,N$
2170   INPUT "DATE",E$
2190   INPUT "MFR",F$
2210   INPUT "MODEL & EQUIP TYPE",G$
2220   INPUT "QUAN & PART NO. ",I$
2230   INPUT "PART DESCRIP",H$
2235   PRINT
2240   INPUT "QUAN & PART NO. ", O$
2245   INPUT "PART DESCRIP",P$
2260   FOR I=1T02
2265   PRINT #7, "------------------"
2270   PRINT #7,
2280   PRINT #7, TAB(20);
 "A.A. CARPENTER"
2290   PRINT #7, TAB(20); "TV SERVICE"
2300   PRINT #7, TAB(20); "GORDONSVILLE,
 VA."
2310   PRINT #7,
2320   PRINT #7, TAB(20);E$
2330   PRINT #7,
2340   PRINT #7,
2350   PRINT #7, A$+L$
2353   PRINT #7, B$+M$
2355   PRINT #7, C$+N$
2358   PRINT #7,
2363   PRINT #7, "GENTLEMEN:"
2365   PRINT #7,
2370   PRINT #7, "PLEASE SEND C.O.D. THE
 FOLLOWING PARTS"
2380   PRINT #7, "FOR A ";F$;" MODEL ";G$;
 " . "
2390   PRINT #7,
2400   PRINT #7,  I$;"     ";H$
2405   PRINT #7,  O$;"     ";P$
2410   PRINT #7,
2420   PRINT #7, "THANK YOU. "
2430   PRINT #7,
2440   PRINT #7, TAB(20);"YOURS TRULY,"
2460   PRINT #7,
2470   PRINT #7,
2480   PRINT #7, TAB(20);"A.A. CARPENTER"
2490   PRINT #7,
2500   NEXT I
2505   PRINT #7,  "------------------"
2510   PRINT #7,  "------------------"
2520   PRINT #7, A$+L$
2530   PRINT #7, B$+M$
2540   PRINT #7, C$+N$
2550   PRINT #7,  "------------------"
2560   PRINT #7, "A.A. CARPENTER, TV
 SERVICE"
2570   PRINT #7, "BOX 841"
2580   PRINT #7, "GORDONSVILLE, VA.
 22942"
2590   PRINT #7,  "------------------"
2600   END ■
```

Microcomputer Timesharing

A Review of the Techniques, With Pointers to Further Reading

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Until I read Steve Ciarcia's article "Having a 'Private Affair' with your Computer" in April 1977 BYTE, page 18, I had not envisaged my 6800 or my 8080 as the basis of a timesharing system. Then I asked myself, "Why not? Why shouldn't a microprocessor be capable of supporting a timesharing system?" I subsequently had the opportunity at the ONLINE conference held in London England on May 14 1977 to see Robert Uiterwyk's 6800 based multiuser system. This prompted me to search back through the literature (especially that of the time when timesharing systems were first being introduced) to check on the problems their designers encountered and their solutions. This article is the outcome. It does not set out to specify in detail how a timesharing system can be established, but it does deal with the main problems involved. Perhaps it will provide a starting point for readers' systems development.

Requirements

Timesharing has been defined in many different ways. For our purpose it will be taken to mean the concurrent, effective utilization of computer resources by several users, possibly at remote terminals. It will imply multiprogramming, possibly multiprocessing; in general, multiple access to system resources.

The key requirement in any multiprogramming or timesharing system is that programs and data should not be bound, that is, converted into hardware dependent form, until the moment of execution. This requirement has many implications and may involve many problems, some of which have been solved in different ways with varying degrees of success. This article examines what is perhaps the main problem: relocating programs and data in a multiprogramming environment. The related problems of scheduling and priority systems, memory addressing algorithms and resource allocation are also discussed briefly.

The Problem

A timesharing system should be designed to execute user programs in such a way as to provide reasonable service and to satisfy each user's requirements. This means that each user should believe that he has all the benefits of a dedicated computer. It is the basic philosophy of timesharing and leads directly to the concept of virtual machines linked to physical computer resources through address mapping tables.

Typically, individual user programs are allowed exclusive use of the computer resources in some order of priority for short periods. They are stopped after a certain time, frequently before completion, to allow other user programs to be given their exclusive use of resources. They are continued at some future time from the point where they were stopped, in either the same memory area or a memory area different from the one they were allocated when first allowed to run.

To be able to continue a program in this way, the system must have facilities to preserve the status of a program when it is

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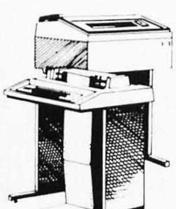
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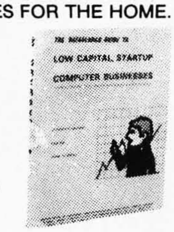
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state	condition
active	in a working state.
wait	ready to run whenever brought into main memory.
user wait	waiting for the user to issue a command.
IO wait	temporarily held up waiting to be serviced by IO device.
file wait	temporarily delayed until another user program has finished using requested program of data file.
dormant	stopped running and has returned control to supervisory program, but its machine conditions have been preserved.
dead	terminated.

Table 1: All possible states that a program may exist in at a particular point in its execution cycle.

stopped and to restore it when it is resumed. That is to say, at the point in time when one user's program is stopped and another user's program is resumed, the instantaneous description of the former program must be saved and the description of the latter restored. These instantaneous descriptions are typically referred to as the current "state" of the user program. The state of a program typically contains such information as the contents of the accumulators, program counter, and condition code register. The stateword might also contain pointers to the address mapping tables which determine the correspondence between virtual and physical addresses.

To explain this process in more detail, it is necessary to examine the factors which make multiprogramming possible and to study a typical system in operation.

Multiprogramming Requirements

Technically, there are a number of considerations which decide whether it is possible to run programs together. In the book *Computer Timesharing* (see references), Popell specifies a minimum of five:

- A supervisory program referred to as executive, monitor, or supervisor.
- An interrupt processing system.
- Memory protection facilities to prevent one program from destroying others.
- Dynamic program and data relocatability so that the same routine can be reentrant. That is, the routine can be used, unmodified, in different memory locations at different times.
- Direct access facilities, or at least the facility for the convenient addressing of peripheral equipment. (For personal computers the floppy disk is the typical example of a direct access device.)

Typically, user programs to be run are stored in auxiliary memory, usually disk, readily accessible so that the supervisory program can switch them into main memory when their times to operate arrive. Each program is allocated the required area in main memory and that area is protected by either hardware or software, from interference by other programs. Any instruction attempting to address an area outside the allocated memory block is trapped and prompts an error message.

A system of priorities is usually implemented. The supervisory program permits the execution of the program with the highest priority until such time as it is suspended for some reason. Priorities are usually determined by a scheduling algorithm which is used by the supervisory program to keep a record of the status of each user program. Table 1 lists all the possible states of a program at a particular point in time.

If, by bringing a program into its area in main memory, there is a storage conflict, the program with the lower priority status must be restored to its place in auxiliary memory. This process is variously called swapping, switching, push-pull or roll out-roll in.

The most common cause of program suspension is a peripheral operation such as IO. But there are others such as a machine or program error or the lowering of priorities. Until suspended, however, user programs run for periods of time determined by the scheduling algorithm. At the end of each program's appropriate time slice (or when it changes status) the supervisory program determines which user program is to be run next. The state of the program which is to be suspended (contents of accumulators, index registers, condition code register, etc) will then be saved either in a supervisor's stack or dumped to auxiliary memory.

The supervisory program then retrieves the next user program from auxiliary storage, together with that program's old state. It loads this program into main memory, processes it, restores it, proceeds to the next user program and so on, until it returns to the first user program to give it a second burst of processing (if required). Then it continues the cycle. It can be seen that the quintessential function of the supervisory program in a timesharing system is scheduling.

Scheduling

On early machines, programs were assembled into the part or parts of main memory they were to occupy during run time in much the same way as they are on microcomputers today. If a large program required too much memory, it was necessary to assemble the program in sections, transferring each section as it was completed to auxiliary storage and restoring it (if nec-

essary in overlays) immediately prior to entry. For this purpose, a suitable portion of memory was reserved for the segment of the program being assembled, and for each instruction two separate addresses had to be recorded: one giving the address of the current instruction and the other indicating the address it would occupy at run time. With elaborations, this technique became the basis of early timesharing systems.

Basic to the running of these early systems was the concept of independent peripheral operation. The processor, having initiated an IO routine for one program, could then proceed to service the computational needs of other programs until the IO routine signaled its completion by interrupting the processor operation. For various reasons, these timesharing arrangements did not fully utilize even the relatively slow storage access time on some computers. The multiprogramming concept was developed fully to realize this potential. The logic was incontrovertible: if the machine had spare memory and spare peripherals, these could have been utilized by a second program. If this still left unused capacity, why not load a third program to use the peripherals and access time not required by the first and second programs; and so on.

Tsujigado showed that it was theoretically possible to process simultaneously a large number of programs (256) in the conversational mode. Although theoretically possible, this would be impractical even now on large computers because of the large memory requirements. In consequence, it is necessary to resort to swapping techniques, and a suitable scheduling algorithm.

The swapping techniques adopted initially depended upon the hardware design (the control mechanisms varied widely between manufacturers and between models). Some hardware is still required for effective control of the process, but the software usually provides the necessary control procedures. In "Computer Software" (see references) Archibald et al specify the necessary software features. They include:

- A means of reserving memory and peripherals for exclusive use by individual programs for predetermined periods of time.
- A means of switching from one program to another to optimize computer performance.
- Facilities to relocate programs dynamically during execution as the overall pattern of programs in the computer changes.

The effect of these routines is to provide multiprogramming facilities which enable

many users to initiate programs and to schedule them through the system according to their relative predetermined priorities.

The simplest system is based on a circular queue for "round robin" scheduling. Each program accepted into the system is assigned a fixed time slice and processor operation is switched from one program to another in round robin fashion until each program is completed. In this arrangement, only one active user program is in main memory at one time. Other active programs are held on disk.

In other systems several user programs may reside in main memory simultaneously. The operational switching between them is controlled by a clock which is used to generate an interrupt to signal the processor that a certain time period has elapsed. The scheduling algorithm is then entered every time a clock interrupt occurs. If it is found that the program in main memory has exhausted its time slice or has changed its status, that program is swapped for the next program in the queue.

Most sophisticated installations of any size find the need to operate a system of queues. The appropriate queue to be serviced by the processor at any particular time will be selected according to priority and program type by the scheduling algorithm. Programs are initiated, or released for processing by being selected from the tops of the various queues which are formed in accordance with the particular installation's design philosophy. In addition to systems of queues, the supervisory program normally has to deal with systems of priorities. Again, what determines these priorities will be a matter of design philosophy. Various criteria are used in practice. Usually it is possible for the system itself to cause priorities to be modified while programs are being queued. Such modifications are especially desirable in real time systems because one program might be continually bypassed; or because a deadline is approaching and the program concerned is not being serviced.

From time to time it may be that a program being queued will have to take precedence over a program being serviced. Downgrading of priorities happens often in scheduling systems. To facilitate this, some operating systems provide a roll in-roll out facility which enables the supervisory program to make a request for processing time on behalf of a higher priority program in the queue. This will result in a lower priority program being rolled out to enable the new program to be processed. Programs rolled out in this way are written into temporary storage along with their current status. When changing circumstances permit the reloading

of programs temporarily suspended, the supervisory program will automatically roll in these programs and they will restart from where they left off.

It may be that the exact locations in memory which such programs and their data were using are no longer available. To deal with this situation, operating systems provide the facility to relocate programs dynamically.

Scheduling Methods

To summarize the discussion so far, there are basically two methods of scheduling:

- Simple swapping systems with only one program at a time residing in main memory for a fixed unit of time in accordance with a system of priorities.
- Elaborate systems which overcome the disadvantage of only one user program in main memory at a time with consequent waste of time due to switching.

This necessity of switching programs into and out of main memory at speeds approaching the internal clock rate leads to further problems which can only be solved with additional hardware and software facilities. In particular, since a given user program does not always get loaded into the same place in memory it leads to addressing problems.

Addressing Techniques

In most systems, individual programmers will have to write their programs without knowing which other programs, if any, will share main memory with theirs. The implication must be that they will need to use symbolic addresses that will be converted to absolute addresses at some time by the supervisory program when allocating memory space and peripherals to the various programs. This necessity has led to the present timesharing philosophy which requires the conceptual separation of absolute storage addresses from the logical system addresses.

In a multiprogramming system, resources are not normally allocated to programs until execution time. Since the physical resources allocated may be different during each time slice, it is essential that the run time representation of programs should be in hardware independent form. This means that the addresses in particular should be virtual addresses. Physical addresses will be represented by an address mapping table which will be updated whenever programs are moved from main memory to temporary storage and vice versa.

As Wegner points out, the structure of the address mapping table will depend not

only on the relation between the virtual address space and the physical address space, but also upon the hardware facilities available for performing address mapping. For example, in "Addressing Structures" (see references) Gammage recalls that the need for dynamic program relocation was met on second generation machines by the provision of a single base register, the contents of which were added to a virtual address generated within the program to map it into an actual main storage address.

The major drawback here was that the program had to be moved between main storage and temporary storage as a single unit (a wasteful process where large programs are involved). It also meant that no program could be larger than the available main memory space.

To overcome these problems, more elaborate addressing structures were devised. These structures reflected the hierarchical organization of problem oriented programs and the need in real time systems to provide for the organization of sets of independent, multiprogrammed jobs. To give the facility of dynamic program relocation, for example, some machines were fitted with special hardware. IBM built upon the addressing system of the IBM 360, which allowed only two levels of addressing, and provided a third level. They did this by providing two sets of additional base registers, one set to act in the same way as the base registers of the IBM 360 (being accessible to the programmer). The other set, sometimes known as segment registers, accessible only to the supervisory program, are used in allocating storage.

Gammage outlines three such schemes, but suggests that because these schemes use variable length segments as the basic unit for storage swapping, they are very inefficient in terms of storage utilization. Their inefficiencies cannot be overcome completely unless a full paging system is employed, using fixed length units for swapping.

Paging

Most modern machines provide some kind of virtual memory structure if they are to be used for multiprogramming. This addressing space may be provided by hardware or created interpretively by software. Most modern systems also interpose an address mapping structure between virtual and physical addresses.

Typically, the virtual address of a word in memory consists of two parts. The first refers to a page number (a fixed size block of main memory). The second refers to a location within the block. In operation, secondary memory is connected to these



blocks through high speed IO devices that permit programs to be swapped directly from disk into any one of the main memory blocks without interfering with processor operation. This process is known as direct memory access and allows execution of one user program in one block of memory while programs are being swapped to and from another block.

Main memory is similarly divided into physical pages, each capable of handling one page of a program or block of data. Program pages, although the same size as main memory pages, will not necessarily be contiguous in main memory and may well occupy different main memory pages at different times. One of the functions of the supervisory program in a paging environment is to form and keep up to date a page table which establishes a mapping of the program and data pages into physical pages. By this means, the address of a page within a program is transformed via the page table into an absolute memory location.

In practice, to achieve dynamic relocation, it is necessary to extend the instruction address to include a segment number as well as a page and location number and to leave the binding of address parameters until run time. The segment number is then used to access a segment table belonging to the user whose program is running at that instant. The reference in the segment table is to the page table which in turn maps onto the physical page and through this to the physical address.

This scheme can be very clumsy and take too long, unless the machine is fitted with additional registers which permit the development of an associative memory. The associative memory combines the segment and page numbers, so that only one interrogation is required to find the number of the physical page containing the appropriate address. Systems in which page registers are designed to be accessed associatively operate various page turning algorithms which determine:

- Whether certain pages are in memory.
- Whether pages are to be preserved or overlaid.
- How recently pages have been used so that, if need be, they can be disposed of when new pages are brought into memory.

These systems are the basis of the virtual memory concept which in turn provides the means for dynamic relocation.

Dynamic Relocation

Let us spell out the need for dynamic relocation in a timesharing system. In general, a program consists of instructions and data.

While being executed it will contain references to intermediate results. These will need to be mapped or translated into references to specific parts of the machine (machine addresses, device numbers, etc). This can be accomplished at three different times:

- During compilation, assembly, or translation into machine code. The result is an absolute program which will be assigned to the same memory locations and use the same peripherals each time it is run, assuming they are available. (This is the most common scheme for user programs in typical personal computers.)
- When the program is loaded. Most machines have a relocating loader which enables programs to be relocated statically.
- During execution, using dynamic relocation.

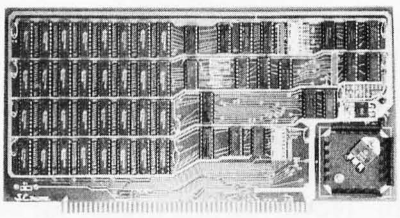
In multiprogramming it is difficult, if not impossible, to allocate memory concurrently to two or more independently written programs if they are absolute programs. The allocation method requires that the particular combination of programs to be run at any one time and their storage requirements are known in advance. This is information that is not always available when the programs are written.

If the absolute addresses are left untranslated by the assembler or compiler and translated by a relocating loader into actual addresses only when the program is loaded for execution, the particular combination of programs to be loaded together can be decided just prior to loading. This method is known as static relocation. Using static relocation it is possible, with a relocating loader, to allocate memory to a program each time it is executed, provided:

- The program can be separated into a data part and a procedure part.
- The procedure part is never modified during execution.
- The data part, including the contents of registers at the time of interrupt, contains no absolute memory addresses.
- When the program is interrupted, the data part is dumped onto auxiliary storage.

These four conditions are not difficult to achieve. Nevertheless, the relocation of an interrupted program by this method has a number of significant drawbacks, which are summarized by Denning in his article "Virtual Memory" (see references).

In dynamic relocation, the translation of virtual addresses to main memory addresses



is delayed until the last possible moment (until access to memory is required in running the program). Because the program contains no absolute addresses, it is independent of the actual memory allocation it receives. This means that it can be interrupted at any time and subsequently reloaded into a different part of memory without modification. This desirable facility can only be achieved at the expense of additional hardware and more complex instruction formats. This is desirable since instructions in general must now hold untranslated addresses in a form appropriate to the relocation technique adopted.

There is also the related problem of storage protection (the need to prevent user programs from interfering with each other while being processed). The usual solution to this problem is to allow them to operate in well defined areas of memory only (unrestricted access to all parts of memory being reserved for the supervisory program only). Frequently the technique used to achieve dynamic relocation can also be used to effect storage protection.

Conclusion

Many programs running concurrently in a multiprogramming environment typically require far larger total memory space than is available in a particular system. The virtual memory concept and dynamic relocation techniques outlined here have solved many of the problems of managing and optimizing the use of large, hierarchical memories. These techniques are often seen in large computer systems and can be adapted (in principle) for use in microcomputer timesharing systems.■

REFERENCES

1. Archibald, HIA, et al, "Computer Software," *Journal of the Institute of Administrative Management,* England, 1966.
2. Coffman, EG Jr, and Kleinrock, L, "Computer Scheduling Methods and their Countermeasures," volume 32, AFIPS, *SJCC,* 1968.
3. Denning, PJ, "Virtual Memory," *Computing Surveys,* volume 2, number 3, Sept 1970.
4. Dennis, JB, "Segmentation and the Design of Multi-programmed Computer Systems," *IEEE International Convention Record,* Part 3, 1965.
5. Dennis, JB, and Glaser, EL, "The Structure of On-line Information Processing Systems," Information System Sciences: *Proc of 2nd Congress,* Walker, DW, ed, 1965.
6. Gammage, ND, "Addressing Structures," *Journal of British Computer Manufacturers,* 1966.
7. Popell, SD, ed, *Computer Timesharing,* Prentice-Hall, Englewood Cliffs NJ, 1966.
8. Tsujigado, M, "Multi-programming, Swapping and Program Residence Priority in the FACOM 230-60," AFIPS, *SJCC,* volume 32, 1968.
9. Wegner, P, "Machine Organization for Multiprogramming," *Proc—ACM National Meeting,* 1967.

A Binary Guessing Game

Calculator Pattern Recognition

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Humans and animals do not as a rule behave at random: instinct and past experience play too important a role. In the computer, a good pseudorandom string of digits isn't hard to produce, but to get genuinely unpredictable output is tremendously difficult.

This article introduces pattern recognition and gives a sample program that recognizes patterns with better than random accuracy. The program is in game format to add to the fun, but it can be easily adapted to other purposes.

We will look only at binary patterns (ie: sequences of 0s and 1s). This is not a limitation, since *any* string of symbols can be encoded into a corresponding binary sequence using a suitable conversion code such as ASCII, and, of course, neurons and flip flops are binary devices. (One could encode the text of this article up to this point in binary, and attempt to predict the rest of what we are going to say; if you want to try, good luck!)

Consider the string:

1 0 1 0 1 1 0 1

What is the next digit?

There is no correct answer, and in fact, there is no "best" answer. A lot depends on what kind of system generated the string. [*Recent mathematical work has shown that, in general, there can be no "best" element following a given string of elements; that indeed any element can be shown to be the correct successor to any given string . . .* CM] If the string were generated by an algorithm with almost no "memory" of the immediate past, but with a possible bias toward 0 or 1 (such as a roulette wheel), a good strategy would be to note the majority of 1s appearing and to bet on 1 in the future, regardless of what the last digit was. On the other hand, a human producing a pattern may tend to repeat sequences made in the past, even if an attempt is made to avoid them.

It is useful to define the term "depth" at this point to mean the longest recent sequence of digits that a program will consider. The basic pattern recognition algorithm we have developed simply looks at the last few digits in a string, checks to see what choice followed that sequence *previously*, and guesses that the same choice will follow this time.

As a specific example, consider the above binary string. A depth 0 algorithm does not look back at all; it has no memory. It simply guesses that the next digit will be the same as the present one (a 1 in the previous example). A depth 1 program checks back to the previous time that a 1 occurred (the sixth digit in our example), and, since it is followed by a 0, makes the prediction 0. A depth 2 routine searches for the previous occurrence of 01, and a depth 3 for 101.

The program listed in this article performs the procedure described above precisely, to depth 3. (Special circumstances which require further processing are discussed below.) All this is not difficult when you have plenty of program and memory space. Implementing it on the HP-25 calculator requires considerable economization, though. If readers with calculators have need of "bit packing and manipulation" it would be worth their while to spend a few hours puzzling out the logic involved, but for applications and gaming, this isn't necessary.

Now that you know the algorithm, it is possible to defeat it in a competition by taking advantage of its weakness (an overreliance on past patterns). For a simple depth N program, it is possible to generate a pattern of length 2^{N+1} that varies in such a fashion that the program is constantly one step behind and *never* gets a right answer. A depth 0 routine, which just guesses that the most recent digit will be repeated again, is fooled by the simple string 1010101010. . . . A depth 1 program will fail when it meets 110011001100. . ., that is, the pattern 1100 repeated continuously. A pattern that will defeat depth 2 is 11101000. This combination is not unique,

but once such a pattern is found and used, the program will always guess incorrectly. We won't mention a pattern to defeat our depth 3 program, but one can be found fairly easily now that you know how it works.

The program is about evenly matched with human opponents. It is very difficult for a human to win decisively (ie: to get more than 15 points ahead) without analyzing the logic of the program. Don't spoil your friends' fun: let them play without first explaining how it works.

Unfortunately we seem to have spoiled the fun by explaining most of the game's logic in this article. If the reader will change step 9 to "4," and step 44 to "÷," the program will acquire new evasive tactics: it is now designed to outthink the readers of this article! It will also recognize much longer patterns, although it takes a bit longer to learn them. Readers can still foil the program in this mode, but the task is considerably more difficult.

Several questions of interest remain unanswered. First, what is the optimum depth for a machine to look when attempting to outguess a human? How much does it depend on who is playing? (Do 6 year olds tend to generate simpler patterns than adults?). Are there other algorithms better equipped to tackle human opponents? Are deeper or more complex programs also more interesting? What about a base 3 number guessing game such as "rock paper scissors," or a more intriguing video display? What is it that makes artificial intelligence (AI) programs so interesting in general? Psychologists and software experimenters might consider working on some of these problems.

Implementation on Other Systems

Our program should be convertible for use on most programmable calculators with conditional branching and several memory registers. It will not work without extensive revision on some microcomputers because it requires at least 8 digit accuracy.

Watch the 10^x function; it must be absolutely, not approximately, accurate for integers in the range between x = +4 and x = –4. If it is not, write a routine to correct it.

Some calculators like the SR-52 do not have the required INT and FRAC functions, but these functions can be easily programmed.

Note that there is an implicit "GO TO 00, R/S" at the end of the program, since this is what the calculator does when it runs past step 49.■

Address	Operation
01	STO + 3
02	STO + 2
03	RCL 0
04	f PAUSE
05	f x ≠ y
06	Go To 09
07	2
08	STO – 7
09	2
10	RCL 2
11	f x ≥ y
12	–
13	g ABS
14	RCL 5
15	x
16	STO + 4
17	8
18	RCL 3
19	f x ≥ y
20	–
21	g ABS
22	STO 3
23	4
24	–
25	g 10^x
26	STO 5
27	RCL 5
28	RCL 1
29	x
30	RCL 4
31	x ≷ y
32	÷
33	g FRAC
34	RCL 1
35	x
36	f INT
37	STO 2
38	x
39	STO – 4
40	f LAST x
41	2
42	STO x 3
43	STO x 2
44	R↓
45	f INT
46	STO 0
47	1
48	STO + 7
49	RCL 7

Listing 1: A pattern recognition program written for the HP-25 programmable calculator. The operator enters a series of binary digits and the calculator attempts to guess each one, giving itself points when successful and penalizing itself when wrong. Unless the operator enters digits that are truly random, the algorithm stands a good chance of detecting patterns in the operator's string of figures.

Instructions for Running the Binary Guessing Game

Step	Comments	Data	Keys
1	Key in program.		
2	Set display digits.		f FIX 0
3	Initialize.		f PRGM f REG
4	Key in values.	10 11.1001 1	STO 1 STO 4 STO 7
5	Clear stack.		f STK
6	Start program.		R/S
7	Program stops with score displayed, for opponent's guess. Enter 1 or 0. (Important: don't enter any other number or run with score displayed.)	1 or 0	R/S
8	HP-25 displays its guess, then the cumulative score: + for opponent, – for HP-25.		
9	Go to step 7.		

Notes: The advanced program described in the article also uses the above instructions. If you convert back to the regular version after running the advanced version, the contents of several memory registers will cause problems. To avoid this, start over at step 3 above. After changing the two steps necessary for the advanced program, remember to return to 00 to run the program. The advanced program will guess 0 for several times until it learns your style. To avoid this, try 123.0123 STO 4.

Languages Forum

Note: *We received the following letter detailing several possible changes to the BASIC language. Readers might try implementing them on their own systems if they do not already have these instructions available . . .* RGAC.

Amended BASIC

Robert Paul Bass II
4827 N 63 Ln
Phoenix AZ 85033

Having been an avid programmer for many years, I've seen many ways for "Mr Murphy" to add some of his handiwork to programs. In order to accommodate some of the beginning programmers, I felt that a new version of BASIC that incorporated some of Mr Murphy's ideas would be appropriate to help explain away some of those mistakes that we all make at some time or another. Here I present some of the new statements and functions that I would like to see in this new version of BASIC.

Assignment

10 LET A # 4*G	Set A to any value **not equal** to the expression.
20 LET B ≃ 19/T	Set B **approximately equal** to the expression.

These are also handy for generating data to test routines that need data close to a particular value, or if any value but one can be used in a program.

IF-MAYBE

```
100 IF G = 17.4 MAYBE 210
```

Advanced implementations of this statement could have nested conditions, ie:

```
110 IF G # A*2 MAYBE 210
THEN AGAIN 300
OR PERHAPS 405
```

Modified FOR – NEXT

```
200 FOR N = 0 TO ABOUT 100
        •
        •
        •
300 NEXT N
```

This statement is used when one isn't absolutely sure how many times to execute a loop.

MISPRINT and MISREAD

```
320 MISREAD A$
330 MISPRINT B,S
```

These are the standard input/output (IO) statements, except that they have a built in glitch generator to produce those inexplicable characters that appear in everybody's output. Caution must be exercised when both of these statements are used in one program because it is possible that the errors could cancel out.

COMEFROM

```
350 COMEFROM 100
```

This is great for debugging programs as it allows the programmer to trace back where he should have been going.

FUZZ Function

```
400 FUZZ = 39
```

This function tells the actual monitor program that executes the BASIC program how picky it will be regarding errors. If FUZZ=0, the program will execute correctly regardless of how many errors there are in the program. If FUZZ=99, the entire system will crash on the smallest logical or even syntactical error.

FORGET

```
440 FORGET 450-560
```

This would be used to indicate which statements should be ignored.

DIMENSIONLESS

```
10 DIMENSIONLESS A,B,C,D,E,F,G,
H,I,J,K,L . . . .
```

This was designed for the theoretical mathematicians working on problems involving points, those zero dimensioned beasties. Systems using this statement should have plenty of memory, since an infinite number of DIMENSIONLESS statements are allowed (and usually needed) so that the programmer can define lines, planes and spaces.

BLINK

500 BLINK 10	Blink for 10 seconds.

This is used primarily in demonstration

Languages Forum is a feature which is intended as an interactive dialog about the design and implementation of languages for personal computing. Statements and opinions submitted to this forum can be on any subject relevant to its purpose of fostering discussion and communication among BYTE readers on the subject of languages. We ask that all correspondents supply their full names and addresses to be printed with their commentaries.

programs where a visitor can see the front panel lights of the computer. When executing this statement the lights will blink in a fashion guaranteed to impress anyone who doesn't know too much about computers. With appropriate interfaces, this could be used with your Christmas tree lights next winter.

GLITCH

530 GLITCH

This is the most invaluable statement that the up and coming programmer can use. It will randomly choose a location in memory or in the internal registers and will change one bit of that word.

SLOWDOWN

650 SLOWDOWN

When entering a particularly difficult portion of a program, this statement would be used to slow down the computer so it won't stumble over the program's harder portion.

WHOA

720 WHOA

Same basic (no pun intended) use as the SLOWDOWN statement but it is primarily used after a series of particularly easy statements to remind the computer that the easy stuff is over and it will have to dig in again and get to work.

I hope that these suggestions for additions to BASIC will inspire some enterprising young programmer to invest a couple of man-years to develop this new version of the old language that we all know and love. Good luck – you'll need it.■

Pascal versus BASIC: Round 2 Includes FORTRAN

Lawrence C Andrews
2634 Wycliffe Rd
Baltimore MD 21234

The article "Pascal versus BASIC: An Exercise," by Allan M Schwartz (August 1978 BYTE, page 168) is a typical example of a language chauvinist using a language ineptly and then pointing to the faults in the code he has written as inherent properties of the language.

The function GCD (page 172) that he has written (leaving aside the BASIC version) has several faults, to wit:

1) X and Y are not declared in the Pascal version.
2) The FORTRAN version will develop an infinite loop if X or Y equals zero (no comment there excludes X, Y greater than zero).
3) The FORTRAN version *never* defines the functional value of GCD and so will not even compile in a good compiler.
4) There sure are a lot of GOTOs and statement numbers in his program; in particular, statement 180 is totally useless. GOTO 180 should be GOTO 120.
5) There is no reason to have any GOTOs. It could be written as in listing 1.
6) If you don't mind downward branching GOTOs (generally considered to be harmless) function GCD can be written as shown in listing 2.

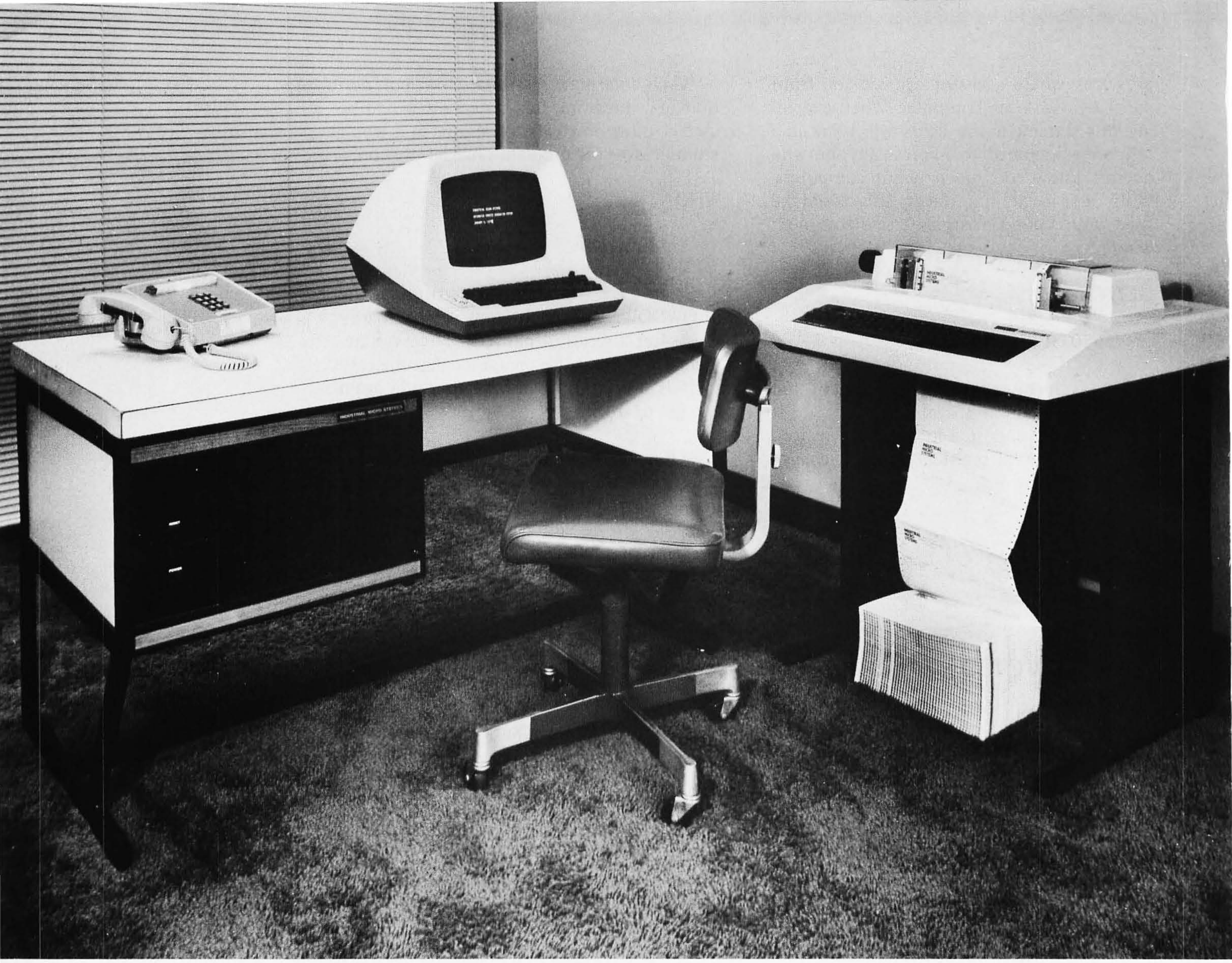
As in Pascal the flow is clear and flowcharting is simple (Warnier-Orr diagrams are still better). I don't run down Pascal but I fail to see why Schwartz runs down FORTRAN just because he writes a pidgin dialect inexpertly. In FORTRAN, as in Pascal, "Go to statements can fog the otherwise clear logic of a routine," as Schwartz states in his article. FORTRAN 77 with IF. . . THEN . . . ELSE statements, and zero trip counts on DO loops, removes most of Schwartz's FORTRAN objection. Anyone can write a bad program in any language. Pascal is no exception to that statement.■

```
INTEGER FUNCTION GCD (X,Y)
INTEGER X,Y, A,B, LIM
C. . .   X,Y .GT. 0
         A = X
         B = Y
         LIM = MAX0 (A,P)
         DO 1000 I = 1, LIM
         IF (A .GT. B) A = A-B
         IF (B .GT. A) B = B-A
         GCD = A
         IF (A. EQ. B) RETURN
1000     CONTINUE
         END
```

Listing 1: The GCD function written in FORTRAN with no GOTO statements.

```
         DO 1000 I = 1, LIM
         IF (A .GT. B) A = A-B
         IF (B .GT. A) B = B-A
         IF (A. EQ. B) GO TO 2000
1000     CONTINUE
2000     GCD = A
         RETURN
         END
```

Listing 2: A much shorter version of the GCD function using one downward branching GOTO statement.



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Note on an Easy Programming System

Mike Brown
POB 2263
West Lafayette IN 47906

I have just completed reading Joseph Weisbecker's article "An Easy Programming System" (December 1978 BYTE, page 108). I was quite favorably impressed—with one minor exception. The random number facility does not seem to be very good, but could be improved with one minor modification. Regardless of what pseudorandom number generator is used, the idea is to provide a sample from a uniform distribution in the range of [0. .KK]. The technique of simply using a mask is clearly not satisfactory. If, for example, KK = 02, the range of pseudorandom numbers is [0. .2]. However, by using the mask, the possible numbers obtained are 0 and 2. It is not possible to get a 1.

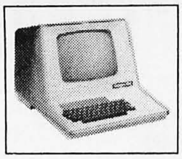
There are several ways around this problem. The simplest is the rejection method in which new pseudorandom numbers are generated until one is found to be small enough. Since most pseudorandom number generation routines I have seen are fairly quick, this method would probably be satisfactory as long as KK is reasonably large.

My suggestion is a refinement of the rejection method, which will work fairly well even as KK gets small:

- Determine high order 1 bit position in KK (p). Form mask with bits 7 thru (p+1) off and bits p thru 0 on (m).
- Generate pseudorandom number in range of [0. .255] (r).
- r2 = r x m.
- If r2 > KK, go to second step. Otherwise r2 is the required pseudorandom number.

In the worst case, only an average of two random numbers will have to be picked, and verifying a good number or rejecting a bad number is a quick and easy task.■

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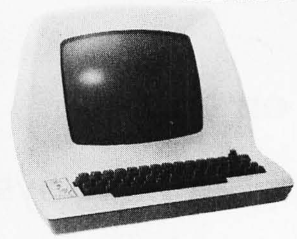
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Some Contrary Opinion

Peter D. Robertson
17047 Via Pasatiempo
San Lorenzo CA 94580

After scanning your August 1978 BYTE, some amusing images came to mind. One was a landscape wherein 10,000 programmers sat in front of their terminals, each one saying, "Gee, if I only had Pascal, I could do this a lot easier than in lousy old BASIC. I really need Pascal." Another image was of Niklaus himself, saying, "Isn't it amazing how many fools there are who ignored Euler, but are wholeheartedly supporting Pascal?" Yet neither language has any real input/output (IO) or was meant for any real machine. Euler was, after all, the more serious effort. Pascal is only a teaching toy.

This is how I see the programming language controversy in the world of personal computing. First of all, Pascal belongs to a class of highly structured, strongly typed languages. This means that it is hard to use. All variables must be explicitly typed, and control structures must follow a rigid syntax, or else the program is garbage. For well-documented, widely distributed programs, this is "good programming practice." For personal computing, this is useless. Secondly, Pascal is difficult to learn.

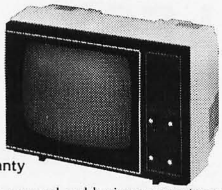
I spent six months studying Pascal intensively, but even so, there are a number of subtleties and nuances of the language which escape me today. Yet it took only two weeks to master BASIC. Thirdly, Pascal was not meant to be debugged. Pascal is so good that every program you write is supposed to be correct. You just type it in, compile it, run it and move on to the next program. If it doesn't work, then hopefully your computer has PDB, the Pascal debugger program, to help you sort things out. Whereas in BASIC, every statement is (or should be) checked for errors when it is entered, not when it is interpreted. For run time errors, most BASICS allow you to print the values of variables and execute statements selectively, changing them as needed, rather than having to recompile every time.

In short, I don't see how Pascal can ever extinguish BASIC as the language of choice for personal computing. For industrial systems programming, sure, but not for personal applications. Pascal is, after all, only a

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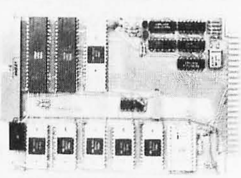
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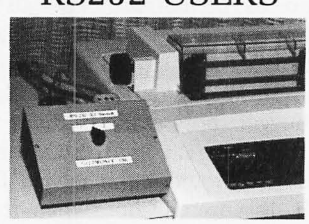
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programming language, whereas BASIC is an entire programming system. If you want to write something neat and elegant, use Pascal, but expect to spend a lot of time on it. If you want to get the job done, however, maybe BASIC isn't so bad.■

How To Define an OS Which Does Not Need a Wizard

James E Jones
123 NE 2nd
Moore OK 73160

I have noted a trend towards microcomputer operating systems which allow programs to be written without worrying about peculiar device interfaces. Nothing could please me more. IO and interrupt programming are the worst part of the transfer from large to micro. There is one disaster that must be avoided, though: the user's interface with it, when it comes, will resemble OS/360 or 370 "JCL" (Job Control Language).

Other than the DD statement, JCL mainly presents tolerable nuisances. Indeed, it once made a perverse sort of sense. JCL is 360 macroassembler with a "//" at the beginning of each statement, and in the times when everybody used assembler and had to know the sordid details of the DCB, it was actually convenient. But in my experience, most people use high level languages now. (I'm from an academic background and probably biased. For purposes of argument, I'll even admit that FORTRAN and COBOL are high level languages.) These people, who enjoy the advantages of such languages when programming, are saddled with large amounts of machine dependent trivia when JCL time comes. Maybe it's not like having to write your own CCWs, but the user must still be concerned with many device peculiarities. (Don't tell me that's what procedures are for. Users must always fill in anything not foreseen by the procedure writer, who can't have much foresight in such cases.) Processes that are easy to think in terms of become cumbersome to write or maybe impossible.

The worst part is that in the name of upward compatibility, the user is forever stuck with it.

So what does this harangue against OS/370 have to do with us? Just this: once an operating system arises in the micro-



world, because of its very real advantages, there will be exactly the same pressures for its maintenance that there are for those of the dinosaurs: rewriting costs, upward compatibility, and difficulties of relearning. The first OS must be the best we know how to write, using the experiences gained from the minis and maxis.

Those who are considering writing an OS, please consider these as possible guidelines:

(1) The OS functions ought to be callable by user's programs, not restricted to the OS or some privileged set of programs. On the 370, users' programs for the most part can only read and write, unless they wish to write assembler programs to subvert the system. All other functions are performed by the OS between jobs or by mysterious, nearly unusable utilities programs. (Around here, they are called the futilities.) Users should be able to write utilities on which natural selection can work. Let only the convenient survive.

(2) The OS functions should be a clean, orthogonal, simple set that does not refer to any device perversities. Not only will such an OS be easier to use, but it would be a true standard, transportable between processors. (Consider the increased ease of communication of programs that would result.) To see how it can be done, read the July 1974 CACM paper on Unix. For heaven's sake, read at least the first three chapters of *Software Tools* by Kernighan and Plauger.

I want a system that I can use without spending all my time fighting its bureaucracy. As time goes on, there will be fewer and fewer hardware hackers, and more people raised on high level languages running on microcomputers. These people will depend on the OS written by the hackers, and it scares me to read about people thinking about IO in big system terms, with a plethora of access methods. If it's done correctly, everyone, including the hackers, will have an environment far better suited for people and working on problems instead of commas, buffers and blocksizes.■

*[Editorial Note: Buried within this letter are numerous references to acronyms which every OS/370 Job Control Language (JCL) hacker must deal with in everyday life. Being lazy, and rationalizing on the grounds of not perpetuating the mistakes, we leave the text as is, filled with references to JCL, DD statements, CCWs, DCBs, and all the other incantations of the wizards of OS. . .*CH*]*

Technical Forum

A Fix for the Dazzler

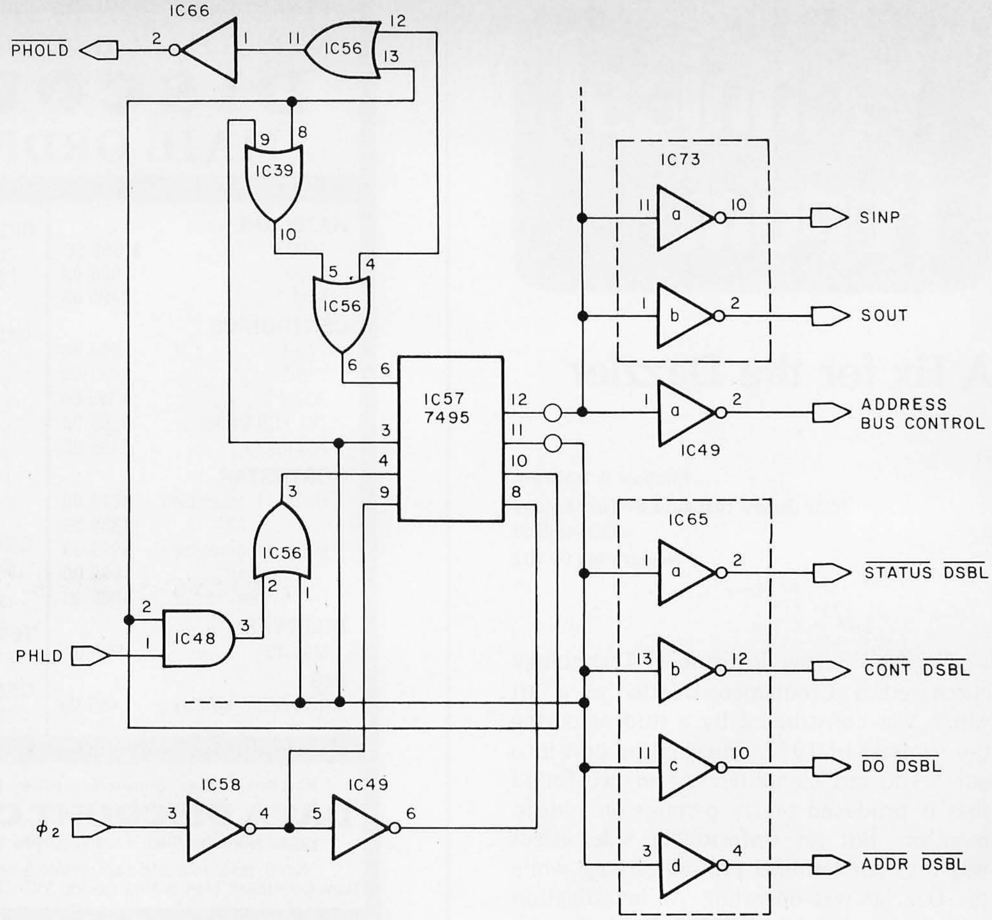
Michael A Baltrush
New Jersey Institute of Technology
323 High St
Newark NJ 07102

The New Jersey Institute of Technology purchased a Cromemco Dazzler as a kit which was constructed by a student during the summer of 1977. Plugging the unit into our S-100 bus computer system, we found that it produced pretty pictures on a video monitor. But an unfortunate side effect was that our terminal printed garbage while the Dazzler was operating. An investigation revealed a pulse on the SOUT line during the time the direct memory access (DMA) transfer was taking place. Cromemco was informed of this by letter and their response was. . . "your serial I/O (input/output) board cannot tolerate DMA." But the problem is deeper than tolerance of an I/O board. Our S-100 system uses a Z-80 processor rather than an Intel 8080. During direct memory access on the 8080, the PHOLD (S-100 pin 74) is asserted by the peripheral and is answered with PHLDA (S-100 pin 26). The PHLDA signal appears at the leading edge of ϕ_1 and the address bus and data bus are floated (put in three-state output condition) at ϕ_2. Thus there is a period of time between PHLDA and the floating of the buses.

During direct memory access of the Z-80, the PHOLD signal is asserted by the peripheral and is answered with PHLDA. The appearance of PHLDA signals that the address bus and data bus are floated with no delay. In use, the Dazzler controls the buses and the signals derived from the control bus. In our system the assumed delay between PHLDA and the floating of the buses does not exist. Therefore, the SOUT signal was uncontrolled during that interval and was treated as a high signal, which is the SOUT assertion level.

A fix for this problem is to take control of all the lines at the assertion of the

Figure 1: Portion of Cromemco Dazzler circuitry which is used to control direct memory access to system memory.



The information in this technical forum was also sent by the author to the newsletter of the Amateur Computer Group of New Jersey.

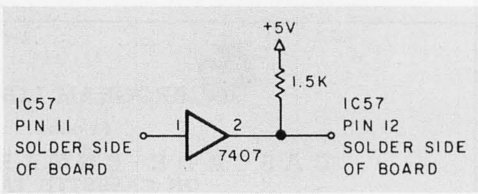


Figure 2: Addition to the Cromemco Dazzler circuit to eliminate problem-causing pulses on the author's Z-80 S-100 bus system. The fix eliminates spurious SOUT pulses that can cause garbage to be printed out on the system printer when the Dazzler is operating.

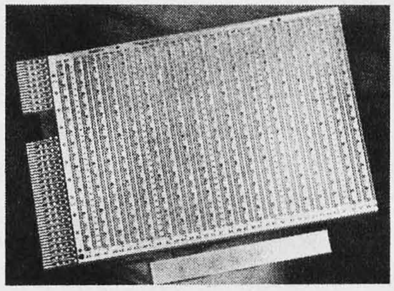
PHLDA signal. This is done by removing IC57 (a 7495), bending pin 12 straight out and reinserting IC57. This removes the effect of pin 12's output from the circuit. A signal must be supplied from pin 11 of IC57. Unfortunately, for simplicity, buffering must be used to be consistent with TTL loading rules. Fortunately, an uncommitted socket exists on board # 2. A 7407, a hex noninverting buffer with open collector output, can be mounted in this socket along with the pull up resistor. The additional integrated circuit is connected as in figure 1.■

What's New?

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

Camac Interface Board for Integrated Circuit Pluggable Wire Wrap Use



Circle 640 on inquiry card.

Camac interface boards for integrated circuit pluggable wire wrap applications are now available from Garry Manufacturing Co, 1010 Jersey Av, New Brunswick NJ 08902. The new boards are plug compatible with the Camac standard instrumentation bus. They provide 38 universal rows of 64 socket terminals per row, with ground and voltage terminals between every other row, spaced .300 inch (.76 cm). The boards will accommodate up to 125 16 pin integrated circuits or an equivalent mix of larger integrated circuits.

The new boards are available at $2 to $3 per integrated circuit position.■

Products for the PET

PET Shack Software House, POB 966, Mishawaka IN 46544 has available a line of products for the Commodore PET. Their products include a complete set of schematics of all the boards in the PET plus parts layout and identification; a complete disassembled listing of all seven read only memories plus identified entry points and machine language monitor program listing; and a multitude of software on cassette. The schematics are priced at $35 and the read only memory routines are $19.95.■

Circle 641 on inquiry card.

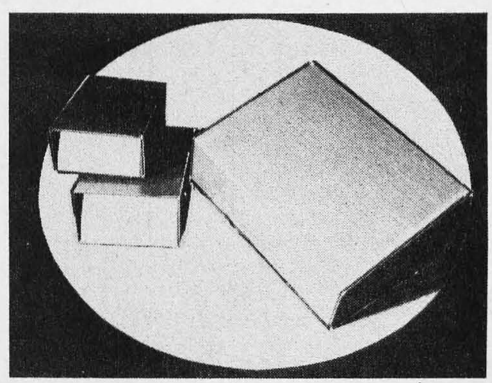
Dust Covers for Computers and Terminals



Cover Craft has recently announced a new line of high quality protective dust covers to fit all popular brands of computers and peripherals. Hundreds of sizes are available, each designed to precisely fit a specific model. Each cover is custom designed and hand cut from high quality textured flexible vinyl. All seams and edges are machine stitched for maximum strength. Contact Cover Craft, POB 555, Amherst NH 03031.■

Circle 642 on inquiry card.

Instrument Enclosures for Designers and Manufacturers



This S series of sloped top panels and the V series of vertical front panels provide a wide range of uses. Vertical and sloping panels are finished brushed and clear anodized. Covers are finished in hard scratch resist, baked-on black textured enamel. Rubber feet and hardware are provided. All models are of flanged construction, using .063 inch (.16 cm) 14 gauge tempered aluminum. A prepunching option on all models is available with instructions upon request. Pricing ranges from $4.43 to $17.90 each in quantities of one to four. For more information contact AAK Corp, POB 7, Methuen MA 01844.■

Circle 643 on inquiry card.

What's New?

PUBLICATIONS

The Computer Book Features Workbook Format

The Computer Book by Fred Lee is an introductory reference for readers, student and nontechnician alike, who wish to improve their understanding of the digital world. This 365 page self-teaching workbook format guide is presented in a clear, straightforward style. In addition to text on each page, the top third of each page graphically represents a memory location which includes memory and address registers to be filled in by the reader so he or she goes through the same logical steps that a computer would follow while running a program. A sampling of the contents includes: number systems and codes, vacuum cleaners and circuits, the instruction set, programming, thumbs-on experience, assembly language, high level language, microprocessors, and microcomputers. The book is priced at $28 and is available from Artech House, 610 Washington St, Dedham MA 02026. ■

Circle 620 on inquiry card.

Teach Yourself How to Use BASIC



BASIC For Home Computers is a self-contained book for learning BASIC. The authors have used Microsoft BASIC for the MITS Altair computer; however, BASIC learned in this book will apply to any computer that understands a similar version of BASIC. This self-instructional book shows you how to read, write and understand BASIC. The material is presented in short numbered sections called frames, each of which teaches something new about BASIC and either asks a question or tells you to write a program.

Answers are given, and numerous applications and games are included. The book is priced at $5.95 and is published by John Wiley and Sons Inc, 605 Third Av, New York NY 10016.■

Circle 621 on inquiry card.

Superior Electric Offers Free Stepping Motor Control Catalog



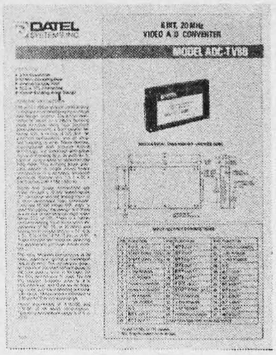
This 28 page catalog covers 16 new Slo-Syn stepping motor controls. It includes new translator and preset indexer modules, power supply modules, open chassis and buffered translators, open chassis preset indexers and completely packaged translators, preset indexers and buffered translators. Controllers drive at rates up to 5000 steps per second (1.8° steps) or 10,000 half steps per second (0.9° steps).

The catalog utilizes charts, specifications, speed versus torque curves and connection diagrams to facilitate selection of correct unit.

For this free catalog write to The Superior Electric Co, 383 Middle St, Bristol CT 06010.■

Circle 622 on inquiry card.

Technical Brochure on Video Analog to Digital Converter



This recently published four page technical brochure by Datel Systems, 1020 Turnpike St, Canton MA 02021, details the electrical and mechanical specifications on the new video analog to digital converter Model ADC-TV8B. This converter features an 8 bit resolution, 20 MHz encoding rate, and an internal high speed sample hold. It is ideal for digital television processing and transmission, radar digitizing, and ultrahigh speed data acquisition systems. Other features in this brochure include block diagrams, timing diagrams, technical notes and applications.■

Circle 624 on inquiry card.

Catalog Offers Used Electronic Instruments

REI Sales Company, which sells used state of the art electronic instruments and equipment, has announced the publication of a new 20 page catalog of equipment for sale. The catalog is available free upon request.

500 different products from 76 manufacturers are listed; items available are amplifiers, analyzers, attenuators, counters, couplers, detectors, filters, generators, meters, microcomputer development systems, oscilloscopes, power supplies, recorders, synthesizers, and miscellaneous equipment.

Terms and conditions of purchase and sale prices of all items are described in this illustrated, indexed catalog, which is available from REI Sales Co, 1 North Av, Burlington MA 01803.■

Circle 625 on inquiry card.

Handbook of Archer Semiconductors



The *Semiconductor Reference Handbook* is a compilation of data on Radio Shack's line of Archer semiconductors. A cross-reference listing for replacement of transistors, diodes and other interchangeable semiconductor devices is listed at the back of the book. The total number of cross-referenced devices exceeds 46,000. These listings are computer selected and are based on analysis of the key parameters of the listed devices.

The price is $1.95. For further information contact Radio Shack, Fort Worth TX 76102.■

Circle 623 on inquiry card.

Interested in Sound Recording?

Home Recording for Musicians by Craig Anderton is a 182 page book which explains how to make professional sounding tapes inexpensively at home. This fully illustrated book includes information on tape decks, multichanneled recorders, microphones, studio setup, tapes, mixing, noise reduction, special effects and more. A special projects section and demonstration record are included. It is priced at $9.95 and is distributed by Music Sales Corp, 33 W 60th St, New York NY 10023.■

Circle 626 on inquiry card.

MEMORY SALE ! have it your way . . .

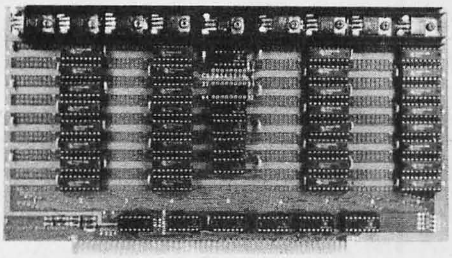
16K $295.00 !! (450 NS)
$327.00 !! (250 NS)

32K $485.00 !! (450 NS)
$549.00 !! (250 NS)

ASSEMBLED AND TESTED ONLY ! . . . . . *Check features before you buy any other memory*

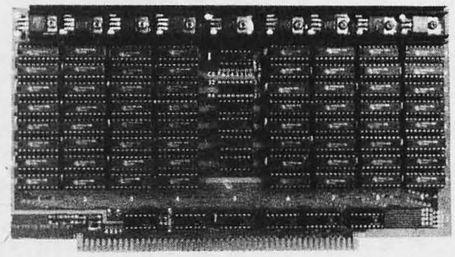
- Extended addressing allows board to exist anywhere in 1 megabyte of memory on standard S-100 bus
- LOW Power, 1.8 Amp per 16K
- 9 Regulators for perfect heat distribution
- Static, of course
- Phantom line
- Each 4K block locateable anywhere
- Fully tested and burned in for 48 hours

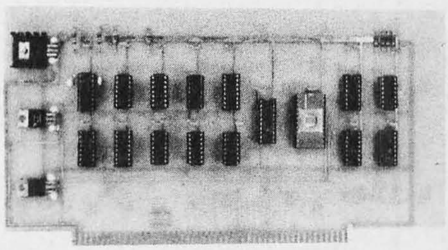
ADD-ON MEMORY CHIPS - $4.95 EACH !! (TMS 4044 or MM 5257) – *8 Chips – Minimum order*



16K ←

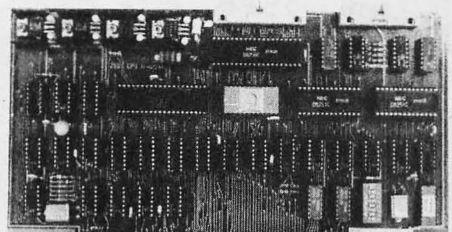
32K →





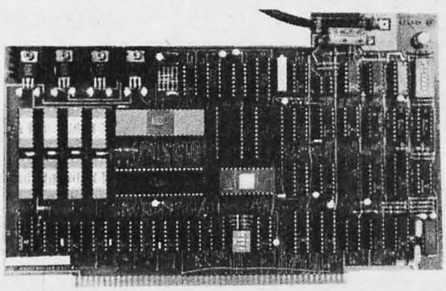
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- Turn banks of memory on and off
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- 2 Parallel + 2 Serial Ports
- 2 MHz or 4 MHz Switch Selectable
- Baud Rates 150-9600
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- Plugs into S-100 Bus and simulates all functions of a Soroc or other RS-232 type terminal. A simple video monitor such as a Sanyo or Sony TV will perform as a smart terminal by writing into an IO Port.
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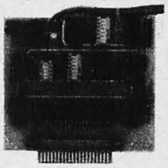
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• Can input into basic • Can use LLIST and LPRINT to output, or output continuously • RS-232 compatible • Can be used with or without the expansion bus • On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line • Requires +5, -12 VDC • Board only $19.95 Part No. 8010, with parts $59.95 Part No. 8010A, assembled $79.95 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. DB25P $6.00, with 9', 8 conductor cable $10.95 Part No. DB25P9.

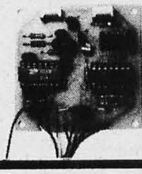


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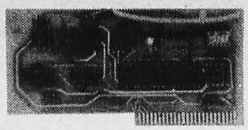
VERBATIM MINIDISK



Box of 10

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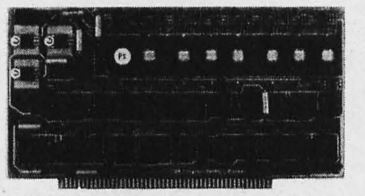
APPLE II ⁂ SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only $15.00 Part No. 2, with parts $42.00 Part No. 2A, assembled $62.00 Part No. 2C

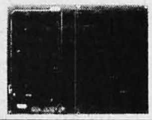
8K EPROM PIICEON

Saves programs on PROM permanently (until erased via UV light) up to 8K bytes. Programs may be directly run from the program saver such as fixed routines or assemblers. • S-100 bus compatible • Room for 8K bytes of EPROM non-volatile memory (2708's). • On-board PROM programming • Address relocation of each 4K of memory to any 4K boundary within 64K • Power on jump and reset jump option for "turnkey" systems and computers without a front panel • Program saver software available • Solder mask both sides • Full silkscreen for easy assembly. Program saver software in 1 2708 EPROM $25. Bare board $35 including custom coil, board with parts but no EPROMS $139, with 4 EPROMS $179, with 8 EPROMS $219.



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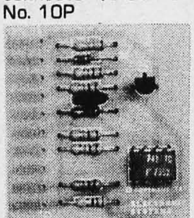
TAPE ⁂ INTERFACE

• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board only $7.60 Part No. 111, with parts $27.50 Part No. 111A



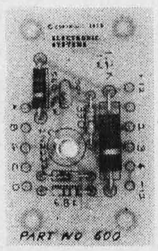
RS-232/ TTL ⁂ INTERFACE

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only $4.50 Part No. 232, with parts $7.00 Part No. 232A 10 Pin edge connector $3.00 Part No. 10P



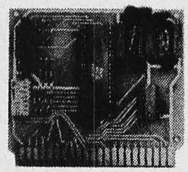
RS-232/ TTY ⁂ INTERFACE

• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only $4.50 Part No. 600, with parts $7.00 Part No. 600A



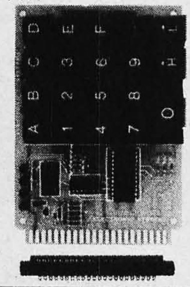
UART & BAUD RATE GENERATOR ⁂

• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00 Part No. 101, with parts $35.00 Part No. 101A, 44 pin edge connector $4.00 Part No. 44P



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This HEX keyboard has 19 keys, 16 encoded with 3 user definable. The encoded TTL outputs, 8-4-2-1 and STROBE are debounced and available in true and complement form. Four onboard LEDs indicate the HEX code generated for each key depression. The board requires a single +5 volt supply. Board only $15.00 Part No. HEX-3, with parts $49.95 Part No. HEX-3A. 44 pin edge connector $4.00 Part No. 44P.



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MEM-1A 8Kx8 fully buffered, S-100, uses 2102 type RAMS. PCBD .... $24.95, $168 Kit

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CPU-1 8080A Processor board S-100 with 8 level vector interrupt PCBD .. $25.95 $89.95 Kit

RTC-1 Realtime clock board. Two independent interrupts. Software programmable. PCBD .... $25.95, $60.95 Kit

EPM-1 1702A 4K EPROM card PCBD .... $25.95 $49.95 with parts less EPROMS

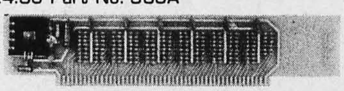
EPM-2 2708/2716 16K/32K EPROM card PCBD .... $24.95 $49.95 with parts less EPROMS

QMB-9 MOTHER BOARD. Short Version of QMB-12. 9 Slots PCBD .... $30.95 $67.95 Kit

MEM-2 16Kx8 Fully Buffered 2114 Board PCBD .... $25.95, $269.95 Kit

S-100 BUS ⁂ ACTIVE TERMINATOR

Board only $14.95 Part No. 900, with parts $24.95 Part No. 900A



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• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50 Part No. 6085, with parts excluding transformers $42.50 Part No. 6085A



To Order: Mention part number, description, and price. In USA, shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Outside USA add 10% for air mail postage and handling, no C.O.D.'s. Checks and money orders must be payable in US dollars. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Prices are in US dollars. No open accounts. To eliminate tariff in Canada boxes are marked "Computer Parts." Dealer inquiries invited. 24 Hour Order Line: (408) 226-4064

⁂ Circuits designed by John Bell

For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

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ACCELEWRITER DOUBLES DECWRITER SPEED

The ACCELEWRITER doubles the LA36 Decwriter's speed from 30 to 60 CPS. The ACCELEWRITER is a small molded module which plugs into the printer's logic board.

The ACCELEWRITER enables the Decwriter to print at its "catch-up" speed of 60 CPS all of the time. You must be able to program fill characters into the data stream after carriage returns.

Easy installation and easy reconversion, if ever desired. Compatible with standard Decwriter option boards. Full one-year warranty. Only $115.00.

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Circle 205 on inquiry card.

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INCLUDES 8 TESTED & GUARANTEED MSK 4116 3 16K RAMS. PROGRAMMING PLUGS & EASY-TO-FOLLOW INSTRUCTIONS.
$72.00 PER KIT

6800 64K BYTE RAM SET AND CONTROLLER CHIP SET

MAKE 64K BYTES OF MEMORY FOR YOUR 6800. THE CHIP SETS INCLUDE:

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32 MSK 4116-3 16K RAMS.
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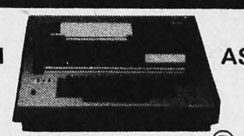
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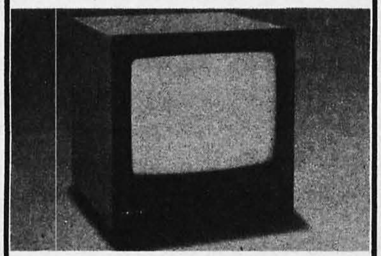
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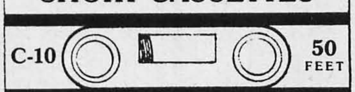
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- Configured as four 4K blocks within a 64K address space.
- Each block separately addressable and write-protectable.
- Components and assembly fully burned-in and tested. One year guarantee.

	Assembled	Kit	Board
250 nsec chips	$340.	$300.	$35.
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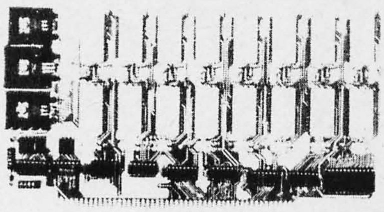
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16K EPROM CARD-S 100 BUSS



$59.95 KIT

OUR BEST SELLING KIT!

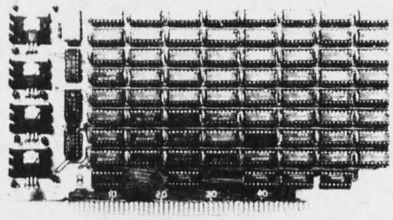
USES 2708's!

Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at **ALL TIMES!** Kit features a top quality soldermasked and silk-screened PC board and first run parts and sockets. All parts (except 2708's) are included. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

OUR 450NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT

ASSEMBLED AND FULLY TESTED ADD $25

8K LOW POWER RAM KIT-S 100 BUSS
250 NS SALE!



ADD $5 FOR 250NS!

$129 KIT

(450 NS RAMS!)

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use.

KIT FEATURES:

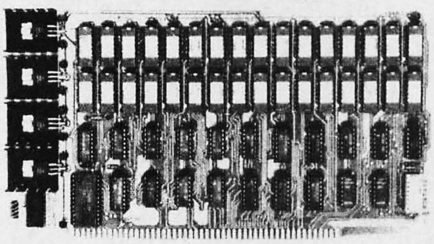
1. Doubled sided PC Board with solder mask and silk screen layout. Gold plated contact fingers.
2. All sockets included.
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67.
5. FOUR 7805 regulators are provided on card.

Blank PC Board w/Documentation **$29.95**
Low Profile Socket Set...**13.50**
Support IC's (TTL & Regulators) **$9.75**
Bypass CAP's (Disc & Tantalums) **$4.50**

ASSEMBLED AND FULLY BURNED IN ADD $30

16K STATIC RAM KIT-S 100 BUSS

$295 KIT



FULLY STATIC, AT DYNAMIC PRICES

WHY THE 2114 RAM CHIP?

We feel the 2114 will be the next industry standard RAM chip (like the 2102 was). This means price, availability, and quality will all be good! Next, the 2114 is FULLY STATIC! We feel this is the **ONLY** way to go on the S-100 Buss! We've all heard the HORROR stories about some Dynamic Ram Boards having trouble with DMA and FLOPPY DISC DRIVES. Who needs these kinds of problems? And finally, even among other 4K Static RAM's the 2114 stands out! Not all 4K static Rams are created equal! Some of the other 4K's have **clocked** chip enable lines and various timing windows **just as critical** as Dynamic RAM's. Some of our competitor's 16K boards use these "tricky" devices. But not us! The 2114 is the ONLY logical choice for a trouble-free, straightforward design.

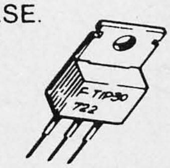
KIT FEATURES:

1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9 LOW POWER: under 2 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA—**$33**
LOW PROFILE SOCKET SET—**$12**
ASSEMBLED & TESTED—**ADD $30**
SUPPORT IC'S & CAPS—**$19.95**
2114 RAM'S—**8 FOR $69.95**

COMPLEMENTARY POWER TRANSISTORS

SILICON NPN AND PNP. TO-220 CASE.
VCEO - 40V PD - 30 WATTS
FOR AUDIO POWER AMPS, ETC.



TIP29 - NPN
TIP30 - PNP

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16K DYNAMIC RAM CHIP

16K X 1 Bits. 16 Pin Package. Same as Mostek 4116-4. 250 NS access. 410 NS cycle time. Our best price yet for this state of the art RAM. 32K and 64K RAM boards using this chip are readily available. These are new, fully guaranteed devices by a major mfg. **VERY LIMITED STOCK!**

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450 NS! 2708 EPROMS

Now full speed! Prime new units from a major U.S. Mfg. 450 N.S. Access time. 1K x 8. Equiv. to 4-1702 A's in one package.

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New! REAL TIME Computer Clock Chip
N.S. MM5313. Features BOTH 7 segment and BCD outputs. 28 Pin DIP. **$4.95 with Data**

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By MOSTEK, or ZILOG. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 158 Z-80 instructions. A MUST reference manual for any user of the Z-80. 300 pages. Just off the press.

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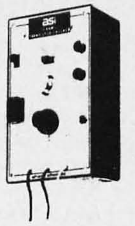
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– Completely Assembled –
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"C" cell battery not included.

Trans-Check **$29.95 ea.**

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DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

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CONNECTORS



25 Pin-D Subminiature

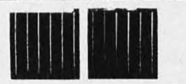
DB25P (as pictured)	PLUG (Meets RS232)	**$2.95**
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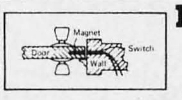


- 0.4 volts
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Ideal for use with clocks, power supplies or any other type of AC application.

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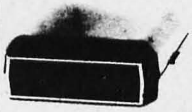
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MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
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	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, −12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
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74S287	1024	Static	2.95

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A total ready-to-use power breadboard prototest device with a built-in regulated, short proof power supply. Just plug in and start building! 2 extra floating 5-way binding posts for external signals. Self-contained with power switch indicator lamp and power fuse. 24-14 pin DIP capacity. Attractive two-tone quality case. All metal construction. 9¾"L x 6½"W x 2¾"H 5 lbs.

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PB-101	6.0 x 4.5 x 1.4	$22.95

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B+K PRECISION 3½-Digit Portable DMM



- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv. 1Va. 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage · 0-1000V
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DC/AC Current: 0-100mA
Resistance 0-10 meg ohm
Size 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

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CSC CONTINENTAL SPECIALTIES CORPORATION 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
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- Fully Automatic
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- Size — 1.75" x 7.38" x 5.63"
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- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
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- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
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Spec Sheets – 25¢
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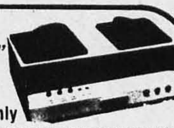
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Transmit Channel Frequencies ..Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity............−46 dbm accoustically coupled.
Transmit Level ....−15 dbm nominal. Adjustable from −6 dbm to −20 dbm.
Receive Frequency Tolerance ...Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
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Power Requirements ....120 VAC, single phase, 10 Watts.
Physical.....................All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

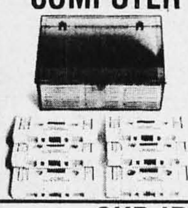
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Expand your 4K TRS-80 System to 16K. Kit comes complete with:
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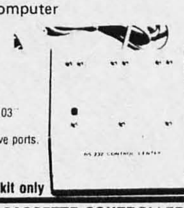


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* Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, TRS-80, Challenger, etc.
* MOD II is pretuned to Channel 33 (UHF).
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The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.



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This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

Circle 200 on inquiry card.

Software Patch for SwTPC 8 K BASIC Adds Disk Data File Capability

A software patch that adds disk data file commands and functions to SwTPC's 8 K byte BASIC has been announced by PerCom Data Company Inc, 4021 Windsor, Garland TX 75042. SwTPC 8 K byte BASIC is for microcomputers that use the 6800 processor.

The software patch is overlaid after 8 K byte BASIC has been loaded in memory. This may be done either manually or from a PerCom disk which includes the patch and a loader program. The modified BASIC takes up 10 K bytes of memory. The patch permits up to four data files to be active concurrently and files may be formatted and updated in place. Formatted files may be accessed randomly.

In addition to OPEN, CLOSE, LOAD and SAVE commands, the program features special instructions that simplify data manipulation. The software patch includes nine commands and functions.

A listing of the patch program and user instruction manual sells for $10. A listing, manual and disk recording of the patch and patch loader sells for $15.■

Circle 593 on inquiry card.

6800 Compiler

Written in 6800 assembly language, this 3 pass compiler (on floppy disk) provides a disk based high level language for microcomputers with at least 16 K bytes of programmable memory. The new language, called STRUBAL (Structured Basic Language), features fully relocatable and linkable code. Versions of the compiler are available for iCOM FDOS-II, Smoke Signal Broadcasting DOS68 and SwTPC Flex.

The software supports a full set of scientific functions, one-dimensional and two-dimensional arrays, three data types (16 bit integer, 10 digit floating point and variable length strings), structured programming forms, string functions, embedded assembly language in the source program and common and dummy sections. Line numbers are not required in source programs. Subroutines may be separately compiled or assembled and called by named parameters.

The price of STRUBAL is $99.95, which includes a user's manual. For further information contact Hemenway Associates Inc, 151 Tremont St, Suite 8P, Boston MA 02111.■

Circle 594 on inquiry card.

Software Package for 8080 and Z-80 Microcomputers

The SOS (single user operating system) package provides the user with a step between the Opus stand-alone high level languages and the Tempos multiuser/multitasking operating system. The SOS package includes: Opus/Three, the high level compiler/interpreter from ASI; Texted, an easy to use, line oriented text editor; Assembl, an 8080 assembler; Files, a diskette file manipulator; and Utilities 1, a package of 12 utilities programs.

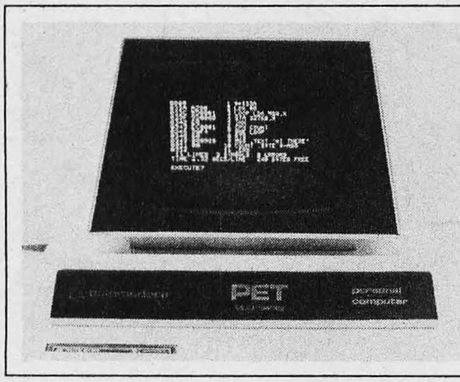
Full upward compatibility has been retained to allow the user of SOS to access data and programs developed at lower levels; all may be used under the TEMPOS operating system as well. All floppy disks and serial device input/output (IO) is handled by SOS; a system generation routine lets the user define IO drivers as required.

The recommended hardware configuration includes an 8080 or Z-80 processor, 32 K bytes of programmable memory, one or two floppy disk drives, and terminals as required. The system typically resides in less than 10 K bytes of programmable memory.

The package is priced at $385 and the user's manual set may be purchased separately for $20, which is credited toward purchase of the SOS package. For more information contact Administrative Systems Inc, 222 Milwaukee, Suite 102, Denver CO 80206.■

Circle 597 on inquiry card.

6502 Assembler in BASIC



The 6502 Assembler in BASIC lets you write programs in assembly language for the 6502 microprocessor and have them translated to machine language for direct execution on the PET. The assembler accepts all standard 6502 instruction mnemonics, pseudo-ops and addressing modes, and evaluates binary, octal, hexadecimal and character constants, symbols and expressions. Source programs can be read from cassette and object programs can be assembled anywhere in memory. The package includes both 1 and 2 pass versions of the assembler, a text editor and a disassembler, and a 30 page manual with PET machine language programming hints, for $24.95. It is available from Personal Software, POB 136, Cambridge MA 02138.■

Circle 595 on inquiry card.

Heurikon Introduces BASIC and Disk Operating System

The Heurikon Corp, 700 W Badger Rd, Madison WI 53713, has announced the addition of Heurikon BASIC and disk operating system (DOS) to its line of MLZ-80 microcomputer products. Heurikon BASIC and DOS is a multilevel system offering two levels of concurrent operation and a disk operating system with file management. The system provides both edit and real time program areas which run concurrently. Real time programs run independently from the keyboard and program editing functions. A real time program is given highest operating priority and may be started automatically in response to external stimuli. Edit area programs will be interrupted to service real time operations. When the real time program completes a task, control is returned to the interrupted point in the edit program. New programs may be developed and tested in edit while the real time program continues to monitor external events. Heurikon BASIC and DOS file management architecture allows any number of variable length files to be cataloged on the disk.

This system is available configured to run on the Heurikon MLZ-80 microcomputer system, which is fully compatible with Intel's SBC Multibus. It can be provided on disk or in erasable programmable read only memory.■

Circle 596 on inquiry card.

Language Family Designed for Z-80 Computers

Designated PLZ, this family of system programming languages is implemented as a set of disk based programs that run in the RIO operating system of Zilog's Z-80 computers. Linkage to other languages such as BASIC, COBOL and FORTRAN is straightforward. PLZ permits a systematic combination of high level machine-independent modules with low level machine-dependent modules within the same program.

The high level modules utilize the procedure oriented PLZ/SYS language. PLZ/SYS blends elements of such languages as Pascal, ALGOL, PL/I, and C to provide a medium for expressing algorithms in a high level, structured fashion. PLZ/SYS requires minimal run time support.

A structured assembly language, PLZ/ASM, provides all of the low level programming capabilities necessary for the user to manage such processor resources as registers, memory, accesses and input/output (IO) operations.

Initial PLZ program implementation consists of the PLZ/SYS compiler, PLZCG code generator, Zinterp interpreter, Plink linker, PLZ/ASM translation filter, and PLZ IO package.

For more information contact Zilog, 10340 Bubb Rd, Cupertino CA 95014.■

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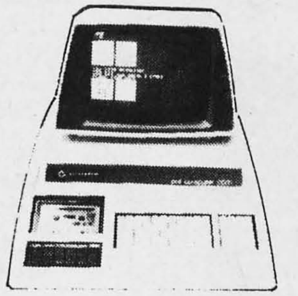
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- 14K ROM, 8K RAM
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The most computer value you can buy in a single box, the PET is a complete system. It's our most popular computer.

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INTERACT Model One

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- Color graphics on your TV
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- Built-in cassette tape drive
- Large 53-key keyboard
- Two joysticks included
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If you can't decide between a sophisticated video game and a home computer then the Interact Model One is for you. Hook it to your color TV and you've got both! You can play one of the games which are included free or you can load Edu-BASIC and write your own games.

Best of all you get over $294 worth of free cassettes.

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For a limited time we are offering Interact's new floating point BASIC by Microsoft free with the purchase of a 16K Interact Model 1. This saves you $49.95 and gives you the most BASIC programming power available in a computer this size. Offer good for orders received before April 31 1978, please mention this ad when ordering.

THE PET CONNECTION

SECOND CASSETTE FOR PET $95
This peripheral from Commodore gives you the ability to use one tape deck for input and one for output to copy files, update records, etc.

Beeper — PET controlled beep	$24.95
Petunia — Play music from your PET	$29.95
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Combo — Petunia Video Buffer combined	$49.95

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Originate Answerback DAA Modem	$320
Dual Port RS-232 Bidirectional Interface	$280
Single Port RS-232 Bidirectional Interface	$240
Cabinet for above interfaces	$35
Serial Printer Interface with case (output only)	$169

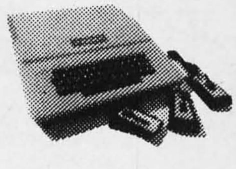
EXIDY SORCERER for $895

- Z-80 Processor
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- User definable characters
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- Interchangeable ROM PACs
- 30 x 64 display
- Resident 4K Monitor ROM
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- Only $895

Top value in our catalog, simply add a monitor and tape decks to complete the system. Can be used as a terminal. Later ROM PACs will offer Z-80 Assembly Language, APL, PILOT, Word Processing and a DOS PAC for disk-based FORTRAN and COBOL. What a system for $895

Sorcerer 8K	$895
Sorcerer 16K	$1150
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16K Expansion	$299

apple II



The most powerful computer you can attach to your TV

NCE/CompuMart now carries the popular Apple II microcomputer system. It easily attaches to any TV and can be used for either business or games. To see why the Apple II continues to be the leader in TV-display computers, write for more information.

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- Beautiful 128 x 128 color graphics
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  - Sockets for additional 4K RAM 16K ROM
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  - Full size (54 key) Alphanumeric keyboard
  - 20 char ASCII Alphanumeric display
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  - Expansion Conn. (try our KIMSI S-100 board)
  - Both connectors totally KIM-1 compatible
- Easy Power connections $375

Options — 4K ROM Assembler/Text Editor
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KIM-1

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SALE Assembled **$169.95**

with power supply **$214.95**

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KIM to S-100 Board	
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Connector Set	15

KIM 4

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Give your KIM a professional appearance. No alterations required, sturdy Kydex 100 Black **$23.50**

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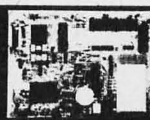


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- 28 Double function keypad including up to 24 "Special" functions
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From Synertek **$269.00**

- Standard interfaces include
  - Audio Cassette Recorder Interface with Remote Control
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- 50 I/O Lines in the basic system

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Datel/Selectric Table-top Terminals



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~~$395~~ $295 AS IS

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- Local remote or wait status selection
- Computer controllable terminal functions
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KTM-2

A new concept in terminals

Only $349.00

Synertek's unique new terminal looks like a keyboard but it contains all the logic to display 24 lines of 40 characters. Upper Lower case and 128 special graphic characters may be output to a monitor (or TV with RF modulator). Local editing (erase line or screen), addressable cursor, scrolling, wrap-around, auto-repeat, optional interface and baud rates to 9600 make this your best buy in terminal boards.

New Acoustic Coupler

$159

NCE/Compumart Inc. breaks the price barrier with a new 300 baud RS-232C acoustic coupler. For only $159 you get an assembled, tested stand alone unit which accepts the standard telephone handset for full or half duplex operation. Complete with power supply and carrier detect light, the unit is housed in an attractive case for desk top use.

SUPER SALE

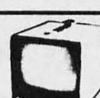
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S-100 MPA

S-100 MPA gives your PET complete control of the S-100 bus (even DMA). Get an assembled unit at kit price.

SALE ~~$225~~



SANYO MONITOR

VM4209 9" quality monitor **$169**

Single board

VIDEO TERMINAL by XITEX

16 Ln x 64 chr. display, 128 printable characters, software UART (ASCII or Baudot), 3 serial interfaces & cassette I/O, true composite video, TTL compatible, easy power connection.

Assembled & tested **NOW $187**

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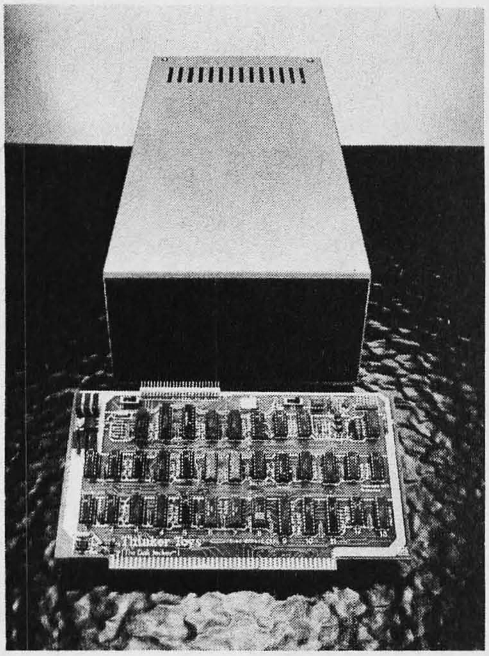
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Circle 195 on inquiry card.

Full Size Floppy Disk Memory Completely Assembled



Discus I is a full-size floppy disk memory for S-100 systems using the 8080 processor. The Discus I is sold as a complete system, assembled and tested, with all required hardware and software. Hardware included in the Discus I system includes a Shugart 800R full-size disk drive fully mounted in a custom, all metal cabinet with an independent power supply; a Disk Jockey I S-100 controller with a capacity for seven additional disk drives; and all necessary cables and connectors.

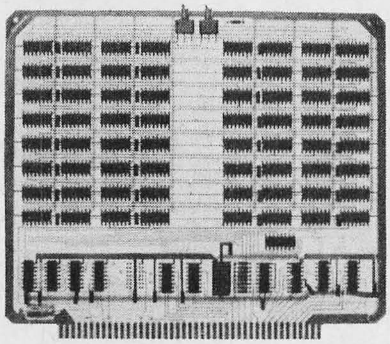
The controller offers an on board serial input and output (IO) port to which all system software has been interfaced. The IO routines can then be modified with the included system software at the user's convenience.

Software included features an integrated Disk/Ate system containing most utilities: disk operating system, file management, system debugger, text editor, batch processor and 8080 assembler. Also included is BASIC-V, a virtual disk BASIC with the ability to address up to 2 M bytes, and to accommodate a wide variety of data types including string-oriented arrays with an unlimited number of dimensions. Also included are patches for CP/M.

The Discus I system sells for $995 plus tax and handling. For users wishing to supplement the Discus I software, several extra cost options are available. CP/M for Digital Research is available for $70. Microsoft Extended Disk BASIC for $199 and Disk FORTRAN for $349 are also available. For further information, contact Thinker Toys, 1201 10th St, Berkeley CA 94710.■

Circle 632 on inquiry card.

Programmable Memory Board for M6800



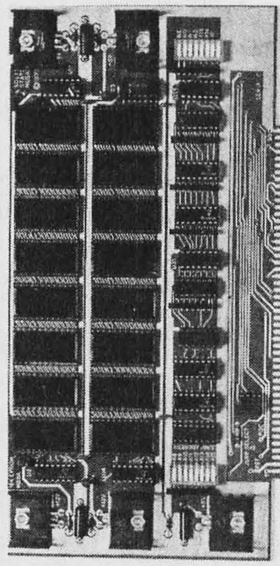
The SME6808 is an 8 K byte by 8 bit low power static programmable memory board for microcomputer systems which utilize the M6800 bus structure. The fully assembled and tested memory board operates from a single 5 V power supply and is available in versions with either 250 ns or 500 ns access time.

The module is organized as two 4 K byte arrays which can be independently located at any 4 K byte boundary in the 64 K byte addressing range of the system. Base address selection for each array is made via on board jumpers. Switches provided on the board allow selection of a read only mode of operation for each of the 4 K byte arrays. This permits the user to simulate read only memory for software development applications, or to protect data from being overwritten during program execution.

Slow memory circuitry can be provided with the SME6808 module. This option permits the 500 ns board to be used in applications with high speed processors or protects investments in memory as high speed processors are added to existing systems.

The price of the 500 ns board is $324.95; the 250 ns version sells for $399.95. Slow memory circuitry is available for either version at an additional cost of $10. Ultra low power modules are also available. Contact American Technologies, POB 23001, Rochester NY 14692. ■

Circle 633 on inquiry card.



Memory Board with Vector Jump

The MB-8A memory board, which uses 2708 erasable read only memories, is fully buffered, has reverse voltage protection, and includes vector jump capabilities which enable the user to jump to any 256 bit location on the board.

Features of the new board include magic mapping, which automatically disables any socket with no read only memory installed, allowing the use of additional programmable memory. The board does not require the use of a front panel. Just reset and go. The MB-8A is plug compatible with all S-100 bus mainframes and has dual-in-line package (DIP) switch selection of eight wait states.

The price of the MB-8A is $95 from SSM, 2116 Walsh Av, Santa Clara CA 95050.■

Circle 634 on inquiry card.

Memory Board for S-100 Bus

PCE Electronics has announced the 16/4+1 erasable read only memory and programmable memory board for the S-100 bus. This board features accommodations for up to 16 2708 1 K word by 8 bit erasable read only memory integrated circuits, addressable in four separate 4 K byte blocks. Any block may be addressed on any 4 K byte boundary in memory and any of the 16 erasable read only memory sockets may be disabled. The erasable read only memory section is capable of generating zero to four wait states.

The programmable memory section of the 16/4+1 utilizes eight 21L02 1 K by 1 bit static programmable memories. The 1 K byte block of programmable memory is addressable on any 1 K byte boundary in memory. Either 250 ns or 450 ns programmable memories are available with the board.

Other features of the board include complete buffering, solder mask, silk screened component location diagram, sockets for all integrated circuits and complete documentation.

The price for the board in kit form is $130, or $155 for an assembled and tested board. The 250 ns programmable memory circuit is $5. For more information contact PCE Electronics, 4782 Dewey Dr, Fair Oaks CA 95628.■

Circle 635 on inquiry card.

ITHACA AUDIO

THE OEM MARKETPLACE

IA Expands S-100 Line

Video Display Board

Featuring a full 128 upper/lower case ASCII character set stored in a 1K buffer memory. Easy to read 16 line x 64 character format can be displayed on an inexpensive video monitor or a modified TV set. Includes a TTY software driver. Add our powerful K 2 FDOS to create a versatile operator console.

$25.00

Disk Controller Board

Controls up to 4 single or double sided drives. Data protect features include automatic disable of write-gate during power-down for data integrity. Supported by a reliable software package, K 2 FDOS and complete diagnostic documentation.

$35.00

K2 Operating System

Power full disk software in the DEC tradition. Includes Text Editor (TED), File Package (PIP), Debugger (HDT), Assembler (ASMBLE), HEXBIN, 1 COPY, System Generator (SYSGEN). Command syntax follows Digitals OS-8, RT/11 format. First in a family of high level software. Soon to be released, FORTRAN & Pascal Compilers.

$75.00

Field-proven reliable engineering

Over 10,000 boards worldwide prove Ithaca Audio provides the quality and reliability you demand.

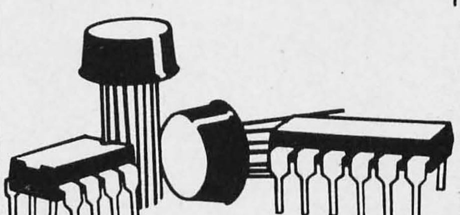
Ithaca Audio Boards are fully S-100 compatible, featuring gold edge connectors and plated-through holes. All boards (except the Protoboard) have fully buffered data and address lines, DIP switch addressing, solder mask and parts legend.

Z-80 CPU Board Most powerful 8 bit central processor available. Featuring power-on-jump, provision for on-board 2708. Accepts most 8080 software. **$35.00**

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32K for $359.

Ithaca Audio is now stocking the Mostek 4115 add-on RAM for S.D.'s Expandoram. Buy their basic board, 32K of RAM from us and SAVE.

S.D. SALES Expandoram board	$199
Ithaca Audio 32 4115's @ $5.00 ea.	160
32K Only	**$359**

Mass Storage at Incomparable Prices.

Ithaca Audio Floppy Disk

- Up to 250K bytes, single sided
- Up to 500K bytes, double sided
- Data protect
- Powerful software operating system includes 8 utility programs, text editor.

Add the capacity of full size disk to your S-100 microcomputer. Controller, Disk Drive, and Software available separately.

Memorex single sided **550 Flexible Disk Drive**	**$456.**
Memorex double sided **552 Flexible Disk Drive**	**$630.**
Disk Controller Board	**$35.**
K2 FDOS Available on 8" floppy disk w. manual	**$75.**

Quality Components

ZILOG Z-80	$19.00
ZILOG Z-80A	23.00
INTEL 2708	11.00
FAIRCHILD 2102 LHPC	1.60
FAIRCHILD 2102 LIPC	1.35

IMSAI 8080 Kit with 22 Slot M.B.

$560.00

plus $10.00 shipping.

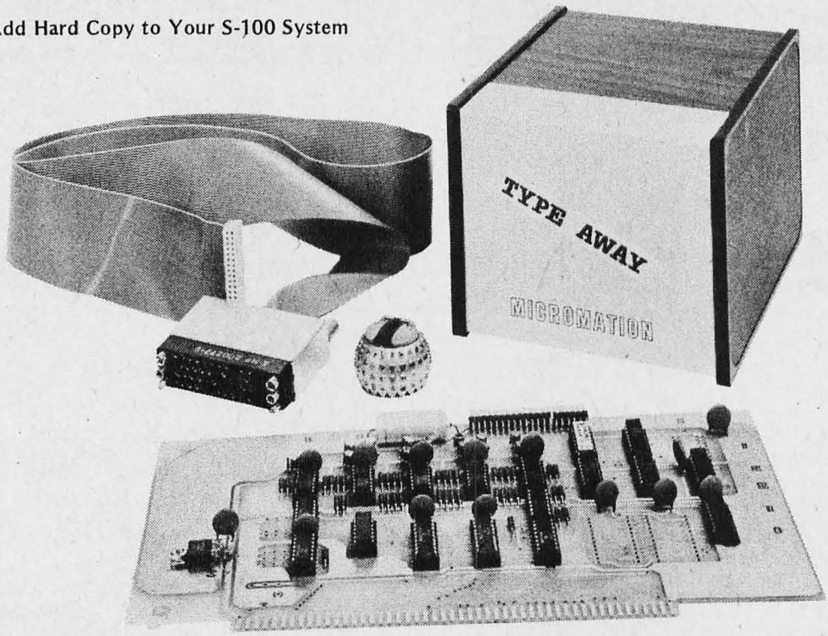
HOW TO ORDER

Send check or money order, include $2.00 shipping per order. N.Y.S. Residents include tax.

For technical assistance call or write to:

ITHACA AUDIO
P.O. Box 91
Ithaca, New York 14850
Phone: 607/257-0190

Add Hard Copy to Your S-100 System



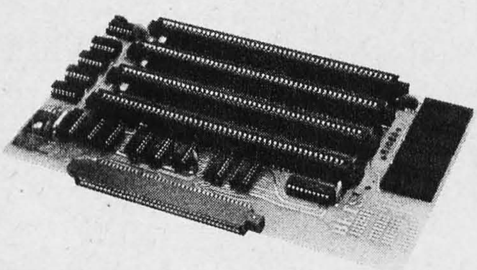
This new Selectric input and output (IO) writer interface, called Typeaway, offers an easy, economical way to add hard copy capabilities to an S-100 system. Typeaway is a complete package of everything required to interface a model 731 or 735 IO writer to an S-100 computer. The total package includes: a single S-100 compatible printed circuit board with solenoid drivers; IO ports; complete software in programmable read only memory; all the cable and connectors needed to connect a Selectric to Typeaway, including a 50 pin A connector; and a versatile DC power supply.

Typeaway can be adapted to work with any factory version of a Selectric IO writer. Software supplied in two 1702A programmable read only memories is all that is necessary to operate a Selectric IO writer as either an input or output device. All control functions and code conversions are programmed in the board's firmware.

The tested and assembled version is priced at $350 and a kit version sells for $275. For further information contact Micromation Inc, 524 Union St, San Francisco CA 94133.■

Circle 570 on inquiry card.

S-100 Expansion for Commodore's PET Computer



Forethought Products, POB 8066, Coburg OR 97401 has announced a PET to S-100 interface and motherboard named Betsi. Betsi is a single circuit board that contains all the necessary logic to interface S-100 boards to the PET.

The board attaches directly to PET's memory expansion connector and provides both interface logic and four S-100 slots on a single compact circuit board. Betsi operates with any S-100 power supply and doesn't interfere with use of PET's parallel or IEEE ports.

In addition to its compatibility with most available S-100 boards, Betsi has an on board dynamic memory controller which allows it to be expanded to 32 K bytes with a single S-100 card.

The kit (which includes one S-100 connector) is priced at $119. $165 is the price for the assembled and tested board (which includes four S-100 connectors).■

Circle 606 on inquiry card.

DEC VT-52 Compatible Video

The Elite 3052A video terminal is a buffered VT-52 compatible terminal with a single page video memory. It offers formatting capability, eight levels of screen enhancements, and a detached keyboard.

The terminal displays 1920 alphanumeric characters in a 24 line, 80 character format and offers a series of features for VT-52 users that includes: an unmatched range of operating modes; host control of block transmit function in local or remote environment; communications flexibility through switch selectable EIA or 20 mA current loop interfaces; buffered support of host-to-printer data transfers; ten user function keys; 8 level video, which requires no memory address space; and 15 data transmission rates, up to 9600 bps, selectable from keyboard.

The Elite 3052A is priced at $1700 in single quantities and $1360 in quantities of 100. Write to Datamedia Corp, 7300 N Crescent Blvd, Pennsauken NJ 08110.■

Circle 607 on inquiry card.



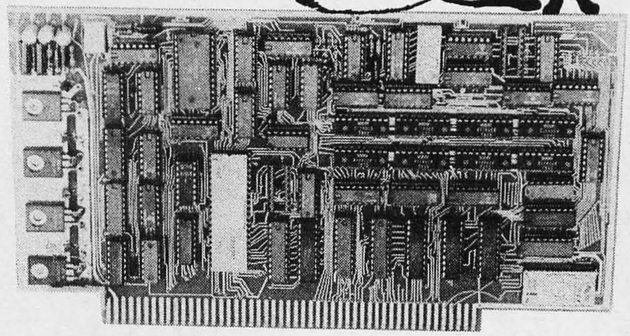
Smart & Foxy

Venus 2001 Video Board

Assembled and Tested $259.95 • Complete Unit with 4K of Memory and Video Driver on Eprom assembled and tested $339.95



kit $199.95



OPTIONAL: • Sockets $10.00 • 2K Memory $30.00 • 4K Memory $60.00 • Video Driver Eprom $20.00 • Text Editor Eprom (Includes Video Driver $75.00)

S-100 Plug-In • Parallel Keyboard Port

On board 4K Screen Memory (Optional). On board Eprom (Optional) for Video Driver or Text Editor Software.

Up and Down Scrolling through Video Memory

Reverse Video, Blinking Characters.

Display: 128 ASC11 Characters 64 X 32 or 32 X 16 Screen format (Jumper Selectable). 7 by 11 Dot Matrix Characters.

American or European TV Compatible (CRT Controls Programable)

Dealer Inquires Invited

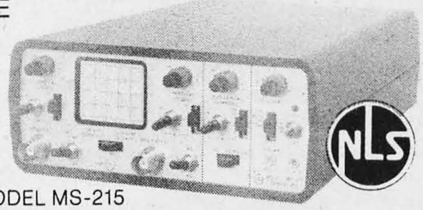
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- Battery or A.C. Operated • External and Internal Trigger
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MS-15 Single Trace Scope $299.

3½ DIGIT DMM LCD Readout



SIZE: 1.3" H 2.7" W 4.0" D

- .5% Accuracy • AC-DC 1-1000V • Ohms 1K-10M
- Current ImA-1 Amp
- 100% Overload Protection

OPTIONAL: • Leather Case $20.00
• NiCad Battery and Charger $16.00

MODEL LM-350

$139.95

3.5 LED DIGITS

Panel Meter



- .5% Accuracy
- Voltage Range 0-1000V
- Power: +5V 200mA
- Auto Zero • Update Rate: 3 Rdg. / Sec.

$52.

MODEL PM-349

ASCII Keyboard Kit $77.



Assembled and Tested $93.00

• Single +5V Supply • Full ASCII Set (Upper and Lower Case) • Parallel Output • Positive and Negetave Strobe • 2 Key Rollover • 3 User Definable Keys • P.C. Board Size: 17-3/16" X 5" • Control Characters Molded on Key Caps • Optional Provision For Serial Output

OPTIONAL: Metal Enclosure $27.50 • Edge Con. $2.00 • Sockets $4.00 • Upper Case Lock Switch $2.50 • Shift Register (For Serial Output) $2.00

Dealer Inquiries Invited

Apple II I/O Board Kit

Plugs into Slot of Mother Board

•1 8 Bit Parallel Output Port (Expands to 3 Ports) •1 Input Port • 15mA Output Current Sink or Source • Can be used for peripheral equipment such as printers, floppy discs, cassettes, paper tapes, etc. • 1 free software listing for SWTP PR40 or IBM selectric.

PRICE: 1 Input and 1 Output Port $49.00
1 Input and 3 Output Ports $64.00

Dealer Inquiries Invited

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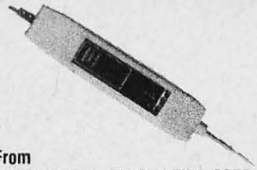
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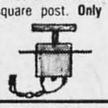
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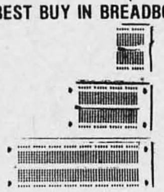


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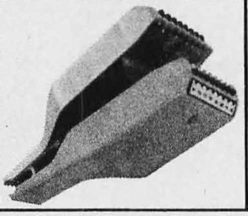
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Instantly monitor logic state of all IC nodes simultaneously. Clip the LM-1 onto and 14 or 16 pin DIP IC. Faster than a scope, safer than a voltmeter, you have an instant display of the static and dynamic logic states of every node. Requires no batteries, input impedance 100K ohms, input threshold 2 V.

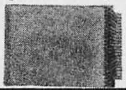
LM-1 **$59.95**



3662 UNIVERSAL "P" PATTERN D.I.P. PLUGBOARD

Made from 1/16 epoxy glass and designed for a 44 pin connector on .156 centers.

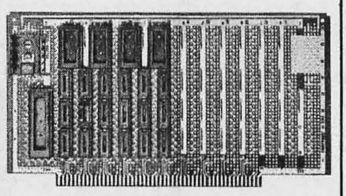
3662	6.5" x 4.5"	**$7.95**
3662-2	9.6" x 4.5"	**$11.95**



8800V and 8801-1 UNIVERSAL MICROCOMPUTER/PROCESSOR PLUGBOARD

Designed to use with S-100 bus. The 8800V includes heat sink and hardware, the 8801-1 is less power bus and heat sink.

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8800V	**$19.95**	**$17.95**	**$15.96**
8801-1	**$14.95**	**$13.46**	**$11.96**

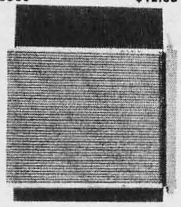


3690-12 CARD EXTENDER

The 3690-12 has 100 contacts, 50 per side on .125 centers. The attached connector is compatible with S-100 Bus Systems.

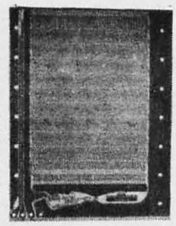
The 3690 is 6.5" 22/4 pin on 158 centers.

3690-12 $25.00
3690 $12.00



8803 MOTHERBOARD FOR S100

Low noise, includes capacitor and spacer kit. Circuitry for active or passive termination. Mounts eleven 100 contacts (S-100 type) connectors. Made from G-10 epoxy glass with solder plated 2 ounce copper and large buses for heavy current, compatible with MIL-STD-275 with 10°C rise. **$29.95**



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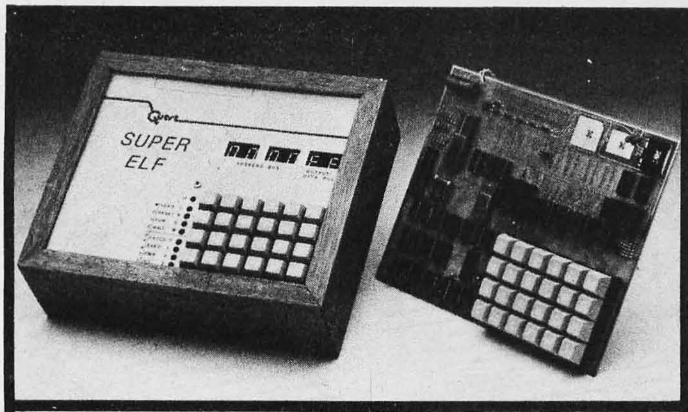
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RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Tiny Basic, ASCII Keyboards, video character generation, etc.**

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on nine LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high** and **low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 90 page instruction manual.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM $38.00. Super Elf owners, 30% off. **Object code listing with manual $5.00. Object list, manual and paper tape $10.00. Original ELF Kit Board $14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A IK Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up.

Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The **Power Supply Kit** for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $5.00. Case $10.00. Add $1.50 for shipping.

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7400N	.17
7402N	.17
7404N	.19
7409N	.23
7410N	.17
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7442N	.50
7445N	.69
7447N	.60
7448N	.69
7450N	.17
7474N	.29
7475N	.49
7485N	.88
7489N	2.00
7490N	.43
7492N	.43
7493N	.43
7495N	.69
74100N	.90
74107N	.29
74121N	.34
74123N	.59
74125N	.39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	.69
74161N	.87
74162N	.87
74163N	.87
74174N	.96
74175N	.90
74190N	1.15
74192N	.87
74193N	.85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL	
74LS00N	.25
74LS02N	.25
74LS04N	.25
74LS05N	.25
74LS08N	.25
74LS10N	.25
74LS13N	.40
74LS14N	.90
74LS20N	.25
74LS22N	.25
74LS28N	.41
74LS30N	.25
74LS33N	.39
74LS38N	.30
74LS74N	.35
74LS75N	.47
74LS90N	.51
74LS93N	.51
74LS95N	1.89
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74LS112N	.35
74LS113N	.35
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74LS136N	.35
74LS151N	.67
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LM311H/N	.90
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LM323K-5	6.95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
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LM340T-8	1.25
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CD4012	.21
CD4013	.36
CD4014	.86
CD4015	.86
CD4016	.36
CD4017	.94
CD4018	.94
CD4019	.21
CD4020	1.02
CD4021	1.02
CD4022	.86
CD4023	.21
CD4024	.75
CD4025	.21
CD4026	1.51
CD4027	.36
CD4028	.79
CD4029	1.02
CD4030	.21
CD4035	1.02
CD4040	1.02
CD4042	.71
CD4043	.63
CD4044	.63
CD4046	1.67
CD4049	.36
CD4050	.36
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	.40
CD4070	.40
CD4071	.21
CD4072	.21
CD4073	.21
CD4075	.21
CD4076	1.75
CD4078	.40
CD4081	.21
CD4082	.21
CD4116	.47
CD4490	5.50
CD4507	1.00
CD4508	4.25
CD4510	1.02
CD4511	.94
CD4515	2.52
CD4516	1.10
CD4518	1.02
CD4520	1.02
CD4527	1.51
CD4528	.79
CD4553	3.50
CD4566	2.25
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CD40192	3.00
74C00	.28
74C04	.33
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	1.95
74C74	.75
74C76	1.40
74C90	1.15
74C93	1.40
74C154	3.00
74C160	1.44
74C175	1.35
74C192	1.65
74C221	2.00
74C905	3.00
74C906	.75
74C914	1.95
74C922	5.50
74C923	5.50
74C925	6.95
74C926	6.95
74C927	6.95

INTERFACE	
8095	.65
8096	.65
8097	.65
8098	.65
8T09	1.25
8T10	4.50
8T13	3.00
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	1.69
8T28	2.75
8T97	1.69
8T98	1.69

MOS/MEMORY RAM	
2101-1	3.95
2102-1	.95
2102AL-4	1.60
21F02	1.25
2104A-4	4.95
2107B	4.95
2111-1	3.75
2112-2	3.95
2114	8.50
4116	12.95
2513B	6.30
21L02-1	1.29
MM5262	.40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-4	5.00
P5101L	13.95
4200A	9.95
82S25	2.90
91L02A	1.50
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	9.95
9368	3.50
410D	10.00
416	16.00

CLOCKS	
MM5309	3.00
MM5311	3.60
MM5312	4.80
MM5313	3.60
MM5314	3.90
MM5315	4.00
MM5316	5.00
MM5318	3.60
MM5369	2.10
MM5841	14.45
MM5865	7.95
CT7001	5.80
CT7002	8.95
CT7010	8.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AB/N	4.90
7205	16.50
7207	7.50
7208	15.95
7209	4.95
DS0026CN	3.75
DS0056CN	3.75
MM53104	2.50

MICROPROCESSOR	
6800	17.50
6802	24.95
8080A with data	8.95
8085	27.00
Z80A	19.75
8212	2.90
8214	8.00
8216	2.90
8224	2.90
8228	5.35
8251	8.50
8253	10.00
8255	9.25
8257	19.50
8259	19.50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	12.50

IC SOCKETS

Solder Tin PIN	1 UP	Low Profile PIN	1UP
8	.15	22	.30
14	.18	24	.35
16	.20	28	.42
18	.27	36	.58
20	.29	40	.57

3 level wire wrap gold.
14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	.25	24	.86
16	.33	28	1.00
18	.57	40	1.23

UART/FIFO	
AY5-1013	5.50
AY5-1014	7.50
3341	6.95

PROM	
1702A	3.95
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
2708	10.50
DM8577	2.90
8223	2.90
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2716 Intel	48.00

CRYSTALS	
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2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

CONNECTORS	
44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	13.50
74C922	5.50
74C923	5.50
HD0165-5	6.95

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	1	10
Red	.55	.47
Black	.55	.47

Keyer 8043 14.50
comp. w/spec./sock.

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2N2222A	.18
2N2369	.30
2N2904A	.20
2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	.18
2N3906	.18
2N3055	.69
2N4400	.25
2N4401	.75
2N4402	.20
TIP31	.60
TIP33A	1.00

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25 Pin Subminiatures

DB25P	2.95
DB25S	3.95
Cover	1.50
RS232 Complete Set	6.50
DE9P	1.50
DE9S	1.95
DA15P	2.10
DA15S	3.10

CLOCK MODULES Complete alarm clocks ready to hook up with transformer and switches. Very compact with .50" and .84" digits.

MA1002A, C or E .50"	8.95
102P3 Transformer	2.25
MA1010A, C or E .84"	11.95
102P2 Transformer	2.25
Special transformer and six switches when purchased w/module	2.95
MA1003 car module .3" green fluor. display	15.95

RESISTORS ¼ watt 5%
10 per type .03 — 1000 per type .012
25 per type .025 — 350 piece pack
100 per type .015 — 5 per type 6.75

KEYBOARDS	
56 key ASCII keyboard kit	$67.50
Fully assembled	77.50
53 key ASCII keyboard kit	60.00
Fully assembled 70.00 Enclosure	14.95

LEDS	
Red T018	.15
Green, Yellow T018	.20
Jumbo Red	.20
Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1.25

(specify red, amber, green, yellow, clear)

CONTINENTAL SPECIALTIES In stock
Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr. $128.95

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DIGITAL THERMOMETER $48.50
Batt. oper. General purpose or medical 32°–230°F. Disposable probe cover ±.2° accuracy. Comp. Assy. in compact case. Switches from F° to C°.

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4K EPROM Kit	114.95
I/O Board Kit	44.50
Extender Board w/connector	12.50
16K EPROM board kit w/o PROMS	74.50
North Star Floppy Disk Kit	$665.00
Additional Drive Kit	415.00

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PC board	7.50
Switches Mom. Pushbutton	.27
3 pos. slide	.25
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MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1.00
DL704	CC	.300	1.25
DL707/DL707R	CA	.300	1.00
DL727/728	CA/CC	.500	1.90
DL747/750	CA/CC	.600	1.95
DL750	CC	.600	1.95
FND359	CC	.357	.70
FND500/507	CC/CA	.500	1.35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	.800	2.20
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5800		40V	3.00
6100		40V	3.00
6100		50V	3.00
7700		50V	2.50
8000		55V	2.50
9400		65V	3.00
10000		20V	2.50
12000		30V	3.50
35000		25V	5.00
55000		25V	5.00
82000		15V	6.00
60000		10V	6.00

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DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

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Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Very accurate. **$39.95**
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NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

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Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

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6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K Assembler $85.00, 8K Basic Interpreter $100.00. Power supply assembled in case $60.00.

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8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $34.95. Woodgrain case $10.00.

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Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

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Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. Foreign $5.00. 1978 IC Master closeout $19.50.

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Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

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Batt/AC oper. 0.1mv–1000v. 5 ranges. 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. $74.95.

S-100 Computer Boards

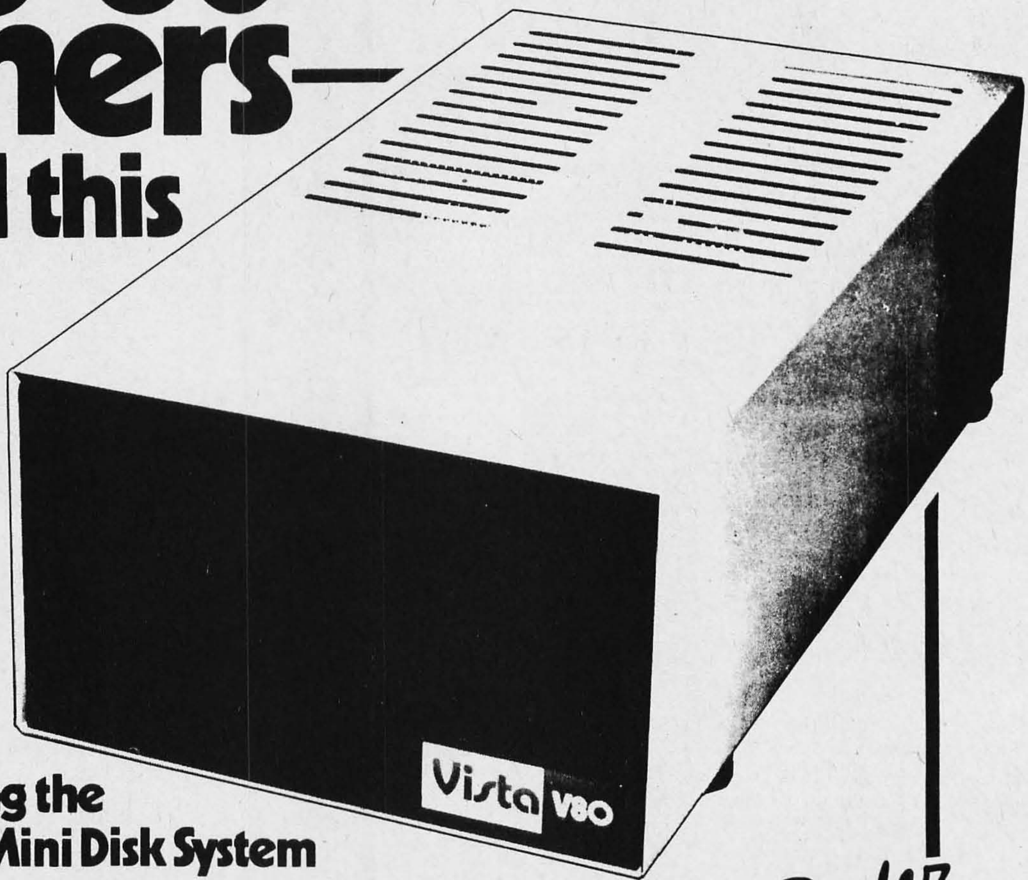
8K Static RAM Kit	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
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Motherboard **$39.** Extender Board	**$8.99**

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- ☐ **HERE'S WHAT YOU GET:** Minifloppy disk drive/Power Supply/Regulator board/Compact case
- ☐ **DOUBLE DENSITY FOR DOUBLE STORAGE** — The V80 will work with the Vista double-density expansion unit when available.
- ☐ **SHIPPED TO YOU READY TO RUN** — Simply take it out of the box, plug it in and you're ready to run.

Dealer inquiries invited

PLUS MORE GOOD NEWS - Vista has a new support team, new address, new telephone, and a new owner. Vista is now part of Advanced Computer Products.

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Vista V-200 Double Density Mini Floppy System with S-100 Controller, CPM on 5¼", power supply & case $699.00

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Vista

Vista Computer Company
1320 E. St. Andrews Place, Unit I
Santa Ana, CA 92705
(714) 751-9201
TWX 910-595-1565

Circle 378 on inquiry card.



ASCII COMPUTER KEYBOARD
This 56 key ASCII encoded keyboard provides debounced ASCII output (7-bit parallel) and strobe. It has six non-encoded closures to ground and requires +5V @ 150MA, -12V @ 45MA. A standard 10 pin dual readout connector is used for data and power inputs. These keyboards were manufactured for use in T.I. Silent 700 series terminals. TESTED AND GUARANTEED. Manufactured by Clare – Pendar.

LIMITED QUANTITY $59.95

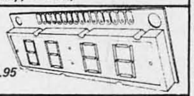


ACOUSTIC COUPLER $47.50
This originate only coupler was manufactured for use in T.I. 735 data terminal. It is compatible with Bell 103 and 113 data sets or the equivalent. The coupler operates asychronously to a speed of 300 baud in the full duplex mode. (Half duplex mode is easily acquired by adding one 1N914.) All signal outputs are compatible with TTL. Transmit freq. is 1270hz. for mark and 1070hz. for space. Receive freq. is 2225hz. for mark and 2025hz. for space. Unit requires ±12 volts and +5 volts for operation. Complete with schematic and all pertinent information. Fully reconditioned, calibrated, and guaranteed.

RS232 to TTL to RS232 conversion kit $6.50. Includes P.C. board, components, and schematic.

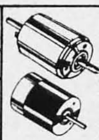
4–DIGIT COUNTER
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Full 4-digit, .5" characters for 4-digit counter, 12 hour, or 24 hour clock. T.I. p/n TIL373, common cathode. $2.95



HP5082-7730
Red .3" LED common anode $1.25. 4/$4.

Send $1.00 for our catalog and get credit on your first order.



12VDC MOTORS
Both the Holland and Maxon are very efficient 12VDC motors. They run on as low as ½V and draw 250ma with 2.8 inch torque at 5000RPM. 1¼" x 1-5/8" long.
Holland double shaft $3.95 ea.
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ZERO CROSSING DETECTOR
SN16268 by T.I. detects when line current is at its minimum for switching devices at zero current. 14 pin dip. 10/$4.95

1K SHIFT REGISTER
National MM5013 in an 8 pin dip. 10 for $4.95

SIGNETICS N8T18A
Dual 2-input high voltage to TTL interface gate. 14 pin dip. 10 for $2.50

MOTOROLA MC1406L
6-Bit digital to analog converter. 14 pin ceramic. $1.50 ea.

MOTOROLA MC1558
Dual op amp in an 8 pin dip. $.49 each 10 for $4.50

SHIFT REGISTER
Fairchild 3341 4X64 digital storage buffer (FIFO) $5.95

TMS4030 DYNAMIC RAM
4096-Bit low power (400mw) with data and 22 pin socket. These units are removed from boards, but are tested and guaranteed.
$3.95 each 10 for $25.00

assortments

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wire

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7 Conductor 24GA. teflon with braid shield and white PVC jacket. (3/16"dia.)
50' for $14.95 100' for $25.00

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Solid silver plated 30AWG available in blue, red, black, yellow, green, or white.
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1000' spool........$9.95

HOOK–UP WIRE
Available in blue, red, white, black, gray, green, yellow, orange, or violet. (stranded PVC)
22 GA.........200' roll.........$3.50
22 GA.........1000' roll.........$12.50
24 GA.........250' roll.........$3.50
24 GA.........1000' roll.........$9.95

POWER CORDS
1) White 2 conductor w/strain relief......3/$1
2) Black 2 conductor w/strain relief......3/$1
3) Black 3 conductor molded vinyl.......$.95
4) Black TV cheater cord........2/$1

switches

MINIATURE TOGGLE
C&K no. 7109 SPDT reset switch. (spring return) $.95ea. 10/$7.50

MINIATURE TOGGLE
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The OP800 consists of a gallium arsenide infrared LED coupled with an npn silicon phototransistor in a plastic housing. The gap in the housing provides a means of sensing motion of opaque objects. Manufactured by OPTRON INC. $1.98 ea.

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T.I. TIL139 is designed for sensing applications such as line finder, batch counter, level indicator, and beginning-of-tape/end-of-tape indicators. $2.50

connectors

"D" SUBMINIATURE CONNECTORS (RS-232 TYPE)
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DB25-S........female........$3.50
DBC25-P......right angle male.....$4.95
AMP hood........$1.50
DC37-P........male........$3.75
DC37-S........female........$4.50
DD50-P........male........$4.50
DD50-S........female........$5.75
Screw lock assembly Cinch D20420..........$.50/pair
Male screw retainer Amp 205980-1..........$.50/pair
Female screw lock assembly Amp 205817-1...$.50/pair

TV CONNECTOR
Cinch Jones 2RP-2. Rated 125V 7A. Used as input voltage connector for TV sets. 10 FOR $1.50
2RP-3, 3-pin version of above. 10 FOR $1.75

SCREW TYPE TERMINAL
Ideal for stereo or TV connector. 1-3/8" mounting ctrs. 20/$1.00 100/$3.95

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22/44 pin .156"ctrs. dip solder........$2.50
28/56 pin .156"ctrs. solder eyelet........$2.95
36/72 pin .125"ctrs. solder eyelet........$3.25
36/72 pin .125"ctrs. wire wrap........$4.25
43/86 pin .156"ctrs. dip solder........$3.95
43/86 pin .156"ctrs. solder eyelet........(used)......$1.00
44/88 pin .125"ctrs. solder eyelet........$4.25

relays

Zestron p/n 540 reed relay, 12VDC SPST N.O. Coil resistance is 800 ohm. $1.00 each
10 for $7.50

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P&B p/n JRM10439 reed relay, 5VDC DPST N.O. Coil resistance is 1000 ohm. $1.95 each 10 for $17.50

P&B p/n JRM10440 reed relay, 5VDC 5PST N.O. Coil resistance 400 ohm. $3.95 each 10 for $34.95

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Precision lead bender for ¼ and ½ watt resistors. ....$1.95ea.

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1033	22 uF TANTALUM, 10V axial	.15
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1117	14 PIN SOLDER TAIL SOCKETS	.19
1117	16 PIN SOLDERTAIL SOCKETS	.20
1117	24 PIN SOLDERTAIL SOCKETS	.36
1001	1N4001, 50V 1A RECTIFIER	20 for 1.00
1018	5.1V 1 WATT ZENER	10 for 1.00
1018	12V 1 WATT ZENER	10 for 1.00
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1020	47uF 6.3V uprite lytic	1.00
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1160	I04 KIT, 2 parallel + 2 serial ports	140.00
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93L22PC	1.10	.96
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9306PC	9.30	8.14
9308DC	3.76	3.29
9308PC	2.70	2.36
9309PC	.64	.56
9310PC	1.00	.87
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9324PC	1.00	.87
9328PC	1.20	1.05
9334PC	1.20	1.05
9338PC	4.28	3.74
9340PC	6.50	5.69
9341PC	4.50	3.94
9342PC	1.00	.87
9360PC	1.10	.96
9366PC	1.10	.96
AM9551PC	5.95	5.10
AM9555PC	5.60	4.80
9600PC	1.70	1.49
9601PC	.78	.68
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AM25LS138PC	.64	.56
AM25LS139PC	.64	.56
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AM26S12PC	3.00	2.62
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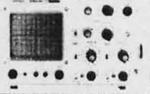
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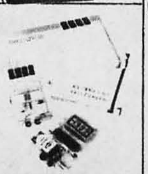
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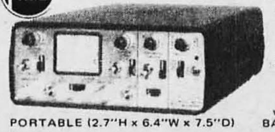
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21L02 250nS.	1.69	1.49	1.45	*	*
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2114 1Kx4 300	8.95	8.50	8.00	*	*
4044 4Kx1 450	5.95	5.50	5.00	*	*
4044 4Kx1 250	9.95	9.50	9.00	*	*
4045 1Kx4 450	8.95	8.50	8.00	*	*
4045 1Kx4 250	9.95	9.50	9.00	*	*
5257 low pow.	7.95	7.50	7.05	6.75	6.45

SPECIAL CIRCUITS

Z80A 4 MHz.	24.95	AY5-1013A UART	4.95
8080A CPU	9.95	Floppy Disc Controllers	
8085	22.50	WD 1771 single D.	39.95
8086 Intel 16 bits	*	WD 1781 Double D	65.00
TMS9900 16 bits	49.95	WD 1791 D/D 3740	*

EPROMS		1-15	16-63	64+
1702A	2K	4.95	4.50	4.00
2708	8K	9.95	9.50	9.00
2716	16K	19.95	*	*
2532	32K	*	*	*

Attention TRS-80 Owners



$650

WORD PROCESSING TERMINAL

LAWYERS, BUSINESSMEN..... This terminal, when properly interfaced to your computer, allows you the flexibility of generating computerized error free correspondence. Gives your clients and business associates the impression that each letter was personally typed for the recipient. Compose your correspondence and "Fill-in" forms on your computer, edit on your screen and when your text is letter perfect instruct your computer to print an error free copy on your terminal.

The heart of this terminal is the durable IBM Selectric Typewriter. If maintenance is ever required, the World Wide network of IBM service centers is at your disposal. The terminal is functional as a regular office typewriter when not performing computer work.

Over the next several months 150 of these terminals will be removed from service, returned to the manufacturer, inspected and brought into perfect condition. Last Spring we offered for sale two-hundred Diablo printers. Within three weeks every unit was sold. Don't pass this opportunity to purchase a word processing terminal at an excellent price.

Selectric Terminal $650 (FOB Los Angeles). Shipping to the East coast aprox. $35. Combined TRS-80 interface and power supply available. Documentation will be supplied to those individuals who want to do their own custom interfacing.

Sorry, but credit cards will not be accepted on this purchase.

Thumbwheel switch

Ten position BCD $1.39 ea.

10	50
$1.19	.89

CAPACITORS

ELECTROLYTICS

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4500/50v.	$1.49	1.35	1.19
1000/15v axial	$.55	.49	.45
.1 disc	$.12	.09	.07
.01 disc	.06	.05	.04

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your choice **$.98**

10	50	100	1k
$.88	.81	.73	.66

SPDT Miniature Toggles

7101 C&K	ON-NONE-ON
7107 jbt	ON-OFF (mnt. ON)
7108 CK	ON-(moment. ON)
Rocker JBT	DPDT
Rotary	3P-4-Pos.
Rotary	3P-6-Pos.
Push B (N.O.)	$.39 ea. 4/$1

DIP Switch

$1.49 ea.

10	25	100	1K
$1.29	1.15	.97	.83

specify 7 or 8 pos. SPST

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14	37¢	36	35	18	17	16
16	38	37	36	19	18	17
24	99	93	85	36	35	34
40	169	155	139	63	60	58

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500	1,000	11,000
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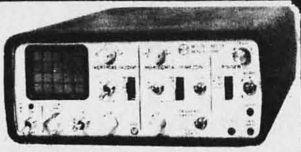
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  Parts & labor guaranteed 1 year
  Tilt stand option .... $ 3.50
- Leather case $20.00

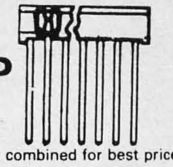


$318. MS-15 MINISCOPE — With Rechargeable Batteries & Charger Unit

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3 LEVEL GOLD WIRE WRAP SOCKETS



Sockets purchased in multiples of 50 per type may be combined for best price.

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8 pin*	.40	.36	.34	.31	.27
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40 pin	1.65	1.45	1.35	1.20	1.10

All sockets are GOLD 3 level closed entry * End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

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S100-WWG 50/100 Cont 125 ctrs 3 LEVEL WIRE WRAP .025 sq. posts on 250 spaced rows GOLD plated
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S100-STG 50/100 Cont 125 ctrs DIP SOLDER TAIL on 250 spaced rows for VECTOR and MASI mother-boards GOLD plated
1-4 $3.50 5-9 $3.25 10-24 $3.00

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R681-3 50/100 Cont 125 ctrs PIERCED SOLDER EYELET tails GOLD $7.53

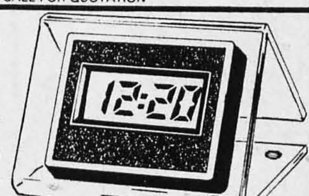
Other Popular Edge Connectors

R644-G 22/44 Cont 156 ctrs PIERCED SOLDER EYELET tails GOLD plated
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R644-3 22/44 Cont 156 ctrs WIRE WRAP tails GOLD
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ATTN: OEM's and Dealers, many other connectors available call or quotation

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- Small in size (2x2½x½)
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- 2 MODELS AVAILABLE:
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- LCD-101 or LCD-102 your choice **$34.95**
- Clear desk stand for **$2.00**

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS — Vector



- Kit includes 12 tantalum capacitors for +5, +12, −12 buses and insulated mounting spacers.
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active, pull-up, or floating terminations
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise
- Fits in Vector-pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

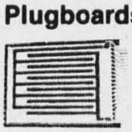
Price: **$29.50**

Vector Plugboards

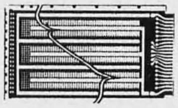


8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware. 5.3" x 10" x 1/16
1-4 $19.95 5-9 $17.95 10-24 $15.96

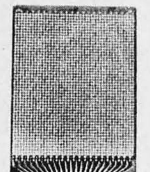
8801-1
Same as 8800V except plain: less power buses & heat sink.
1-4 $14.95 5-9 $13.46 10-24 $11.96



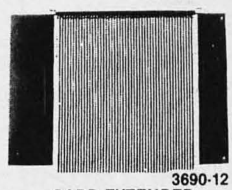
3682 9.6" x 4.5" $10.97
3682-2 6.5" x 4.5" $9.81
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156



3662 6.5" x 4.5" **$7.65**
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P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156



3690-12
CARD EXTENDER
Card Extender has 100 contacts 50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems. $25.83
3690 6.5" 22/44 pin .156 ctrs. Extenders $13.17

1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

Phenolic PART NO.	SIZE	PRICE 1-9	10-19
64P44XXXP	4.5x6.5"	$1.56	$1.40
169P44XXXP	4.5x17"	$3.69	$3.32
Epoxy Glass			
64P44	4.5x6.5"	$1.79	$1.61
84P44	4.5x8.5"	$2.21	$1.99
169P44	4.5x17"	$4.52	$4.07
169P84	8.5x17"	$8.03	$7.23

TRS-80
MEMORY EXPANSION KITS
4116's RAMS
(16Kx1 200ns)
8 for $65.00

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8K 450 ns
EPROM
FACTORY PRIME
$12.00 EA.
25 + *Call For Price*

WOW 14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKETS



14 - G3 100 for **$30.00**
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Sockets are End & Side stackable, closed entry

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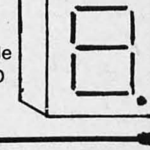
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Perfectly balanced fluorescent lighting with precision magnifier lens. Tough thermoplastic shade. Easy lens removal. New wire clip design permits easy installation and removal of fluorescent tube. Comes with plastic shield to protect tube from soiling and damage.
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FND 503
Common Cathode
FND 510
Common Anode
½" 7 seg LED
59¢
10/$4.50



Vector
WRAP POST
for .042 dia. holes
(all boards on this page)
T44/C pkg. 100 .. $ 2.34
T44/M pkg. 1000 ..... $14.35
A-13 hand installing tool .... $ 2.94

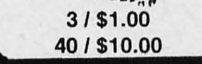
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24 PIN DIP PLUGS WITH COVERS



3 / $1.00
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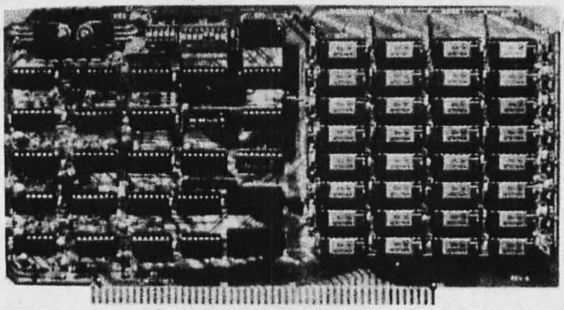
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SD EXPANDORAM

The Ultimate S-100 Memory



The EXPANDORAM is available in versions from 16K up to 64K, so for a minimum investment you can have a memory system that will grow with your needs. This is a dynamic memory with the invisable on-board refresh, and IT WORKS!

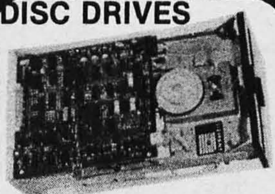
- Bank Selectable
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- Power 8VDC, ± 16VDC, 5 Watts
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- Uses Popular 4116 RAMS
- PC Board is doubled solder masked and has silk-screen parts layout.

- Extensive documentation clearly written
- Complete Kit includes all Sockets for 64K
- Memory access time: 375ns, Cycle time: 500ns.
- No wait states required.
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EXPANDO 64 KIT (4116)

16K $245.00
32K $310.00
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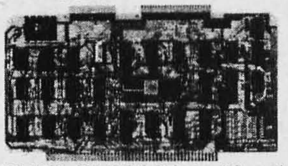
Sugart SA400 5¼"
$295.00

GSI/Siemans
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$395.00
*equivalent to Sugart 801

Siemens FDD 200-8 8" double-sided double density
$599.00

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SD "VERSAFLOPPY" Kit

The Versatile Floppy Disk Controller — Only $159.00



FEATURES: IBM 3740 Soft Sectored Compatible. S-100 BUS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:
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2. Shugart SA800/850 Standard Floppy.
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4. MFE 700/750.
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34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Comptler. The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. FD1771B-1 Single Density Controller Chip. Listings for Control Software are included in price.

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- 20 Hz-100 MHz Range
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- Fully Automatic
- Portable - completely self-contained
- Size - 1.75" x 7.38" x 5.63"
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~~$134.95~~ **Sale $120.00**

ACCESSORIES FOR MAX 100:
Mobile Charter Eliminater use power from car battery. **Model 100—CLA $3.95**

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CONTINENTAL SPECIALTIES CORPORATION — CSC

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Trace signals through all types of digital circuits. Unit clips over any DIP IC up to 16 pins. Each of its 16 contacts connects to a single-bit level detector that drives a high-intensity, numbered LED readout activated when the applied voltage exceeds a fixed 2 V threshold. Logic "1" turns LED on; logic "0" keeps LED off. A power-seeking gate network automatically locates supply leads and feeds them to the LM-1's internal circuitry. Saves minutes, even hours in design, troubleshooting, debugging of equipment. **Voltage Threshold:** 2 V ± 0.2 V. **Input Impedance:** 100,000 ohms. **Input Voltage Range:** 4-15 V max. across any two or more inputs. **Current Drain:** 200 mA at 10 V. *Size:* 4" l. x 2" w. x 1.75" d. when open. *Weight:* 3 ozs.

CSC Model LM-1 Logic Monitor—Complete.
List Price **$54.95**

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SALE



SALE

LOGIC PROBES

CSC logic probes are the ultimate tool for breadboard design and testing. These hand-held units provide an instant overview of circuit conditions. Simple to use; just clip power leads to circuit's power supply, set logic family switch to TTL/DTL or CMOS/HTL. Touch probe to test node. Trace logic levels and pulses through digital circuits. Even stretch and latch for easy pulse detection. Instant recognition of high, low or invalid levels, open circuits and nodes. Simple, dual-level detector LEDs tell it quickly, correctly. HI (Logic "1"); LO (Logic "0"). Also incorporates blinking pulse detector. e.g., HI and LO LEDs blink on or off, tracking "1" or "0" states at square wave frequencies up to 1.5 MHz. Pulse LED blinks on for ⅓ second during pulse transition. Choice of three models to meet individual requirements; budget, project and speed of logic circuits.

MODEL LP-1
Hand-held logic probe provides instant reading of logic levels for TTL, DTL, HTL or CMOS. **Input Impedance:** 100,000 ohms. **Minimum Detectable Pulse:** 50 ns. **Maximum Input Signal (Frequency):** 10 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** Pulse or level transition detected and stored.
CSC Model LP-1 Logic Probe—Net Each **$42.70**

MODEL LP-2
Economy version of Model LP-1. Safer than a voltmeter. More accurate than a scope. **Input Impedance:** 300,000 ohms. **Minimum Detectable Pulse:** 300 ns. **Maximum Input Signal (Frequency):** 1.5 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** None.
CSC Model LP-2 Logic Probe—Net Each **$23.70**

MODEL LP-3
High speed logic probe. Captures pulses as short as 10 ns. **Input Impedance:** 500,000 ohms. **Minimum Detectable Pulse:** 10 ns. **Maximum Input Signal (Frequency):** 50 MHz. **Pulse Detector (LED):** High speed train or single event. **Pulse Memory:** Pulse or level transition detected and stored.
CSC Model LP-3 Logic Probe—Net Each **$66.45**

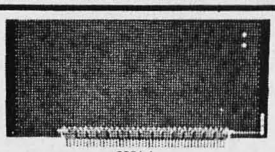
DIGITAL PULSER
The ultimate in speed and ease of operation. Simply connect clip leads to positive and negative power, then touch DP-1's probe to a circuit node; automatic polarity sensor detects circuit's high or low condition. Depress the pushbutton and trigger an opposite polarity pulse into the circuit. Fast troubleshooting includes injecting signals at key points in TTL, DTL, CMOS or other popular circuits. Test with single pulse or 100 pulses per second via built-in dual control push-button; button selects single shot or continuous modes. LED indicator monitors operating modes by flashing once for single pulse or continuously for a pulse train. Completely automatic, pencil-size lab/field pulse generator for any family of digital circuits. **Output:** Tri-state. **Polarity:** Pulse-sensing auto-polarity. **Sync and Source:** 100 mA. **Pulse Train:** 100 pps. **LED Indicator:** Flashes for single pulse; stays lit for pulse train.
CSC Model DP-1 Digital Pulser—Net Each **$71.20**

Vector



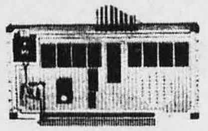
4607
DEC LSI-11, PDP8, PDP11, Heath H-11, P Pattern Epoxy Glass, Plug Board 8.43"x5.187" Dual 36 pin DEC/HEATH Connectors.

1-4	5-9	10-24
19.95	17.96	15.96



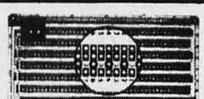
8801-1
Plain no etched circuitry except contacts. Produces maximum flexibility.

1-4	5-9	10-24
14.95	13.46	11.96



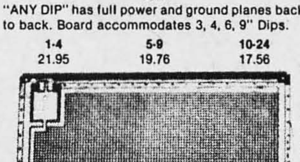
8802-1
Pad per 2 holes. Two-holE pads allow tack soldering of socket, plus second hole for component leads.

1-4	5-9	10-24
21.95	19.76	17.56



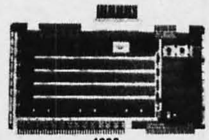
8804
"ANY DIP" has full power and ground planes back to back. Board accommodates 3, 4, 6, 9" Dips.

1-4	5-9	10-24
21.95	19.76	17.56



8801
Individual tinned square pads surround most holes. Ideal for mounting components by "tack soldering" Top of board pod free for mounting I/O connectors.

1-4	5-9	10-24
19.95	17.95	15.96



4608
Is form and size compatible with INTEL SBL80 Series and NATIONAL BLC 80 Series microcomputer boards. Power and Ground buses on both sides.

1-4	5-9	10-24
45.00	40.50	36.00

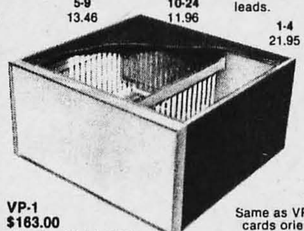
4608-1
Same as 4608, except plain less power buses.

104	5-9	10-24
34.00	30.60	27.20

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DESCRIPTION
Assembled case with perforated bottom cover. Installed mounting struts for card guides and receptacles or mother board. Cards top loaded, spanning front to back. Card guide (12 pair) and chassis plate supplied uninstalled.



VP-2

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$163.00
Shipping Weight 25 lbs.

VP-2
$159.00
Same as VP1 except cards oriented side to side.

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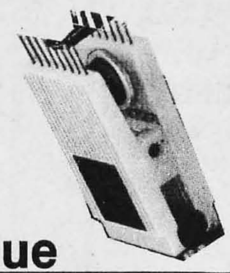
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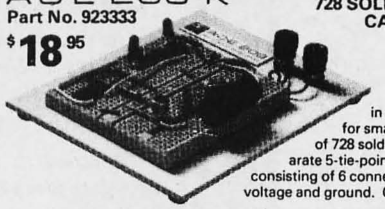
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a $4.75 Value



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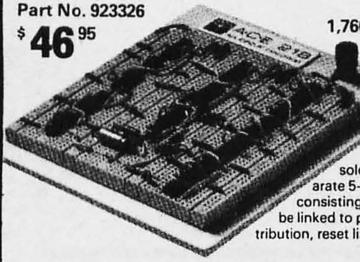
A·C·E 200-K
Part No. 923333
$18.95



728 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 8* 16-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 5-9/16"
- Kit form — lowest cost

This handy breadboard kit, the smallest in the ACE series, offers excellent versatility for small circuit check-out. The universal matrix of 728 solderless, plug-in tie points includes 136 separate 5-tie-point terminals and 2 distribution buses, each consisting of 6 connected 4-tie point terminals . . . typically for voltage and ground. Complete assembly instructions included.

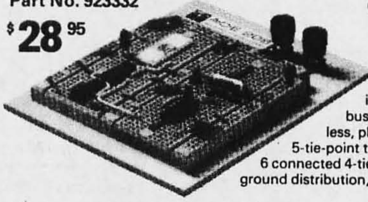
A·C·E 218
Part No. 923326
$46.95



1,760 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 18* 14-PIN DIP's
- Two 5-way binding posts
- Size: 6-1/2" by 7-1/8"
- Fully assembled

This intermediate breadboard in the ACE series provides even greater circuit-building flexibility. The universal matrix of 1760 solderless, plug-in tie points is comprised of 288 separate 5-tie-point terminals and 10 distribution buses each consisting of 9 connected 4-tie-point terminals. Buses may be linked to provide functions such as voltage and ground distribution, reset lines, clock lines, shift command, etc.

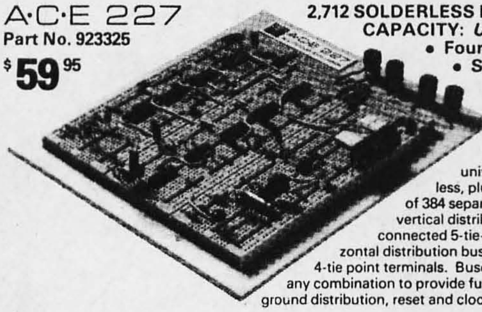
A·C·E 208
Part No. 923332
$28.95



872 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 8* 16-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 5-9/16"
- Fully assembled

Model 208, the smallest assembled board in the ACE series, has 6 more distribution buses than the 200-K. The matrix of 872 solderless, plug-in tie points is comprised of 136 separate 5-tie-point terminals plus 8 distribution buses, each with 6 connected 4-tie-point terminals. Use buses for voltage and ground distribution, reset lines, clock lines, shift command, etc.

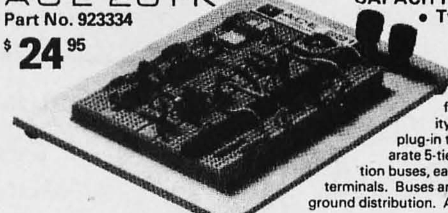
A·C·E 227
Part No. 923325
$59.95



2,712 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 27* 14-PIN DIP's
- Four 5-way binding posts
- Size: 8" by 9-1/4"
- Fully assembled

Model 227 has greater capacity for components and more buses than the 218. The universal matrix of 2712 solderless, plug-in tie points is comprised of 384 separate 5-tie-point terminals, 24 vertical distribution buses (each with five connected 5-tie-point terminals) plus 4 horizontal distribution buses (each with 12 connected 4-tie point terminals. Buses may be linked together in any combination to provide functions such as voltage and ground distribution, reset and clock lines, shift command, etc.

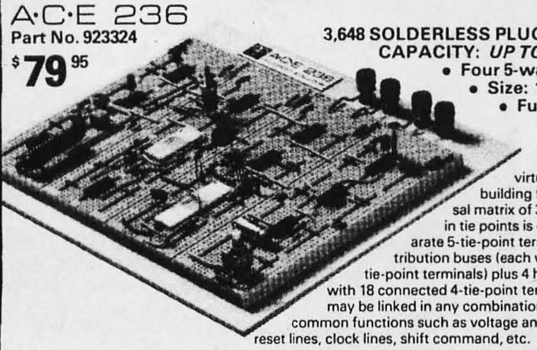
A·C·E 201-K
Part No. 923334
$24.95



1,032 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 12* 14-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 7"
- Kit form

Here's the larger of the two kits in the ACE series. . . for larger circuit-building capacity. The matrix is 1032 solderless, plug-in tie points comprised of 192 separate 5-tie-point terminals and 2 distribution buses, each with 9 connected 4-tie-point terminals. Buses are typically used for voltage and ground distribution. Assembly instructions included.

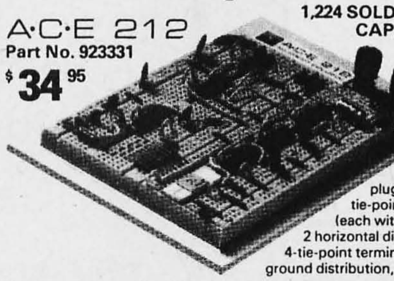
A·C·E 236
Part No. 923324
$79.95



3,648 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 36* 14-PIN DIP's
- Four 5-way binding posts
- Size: 10-1/4" by 9-1/4"
- Fully assembled

Model 236, the largest in the ACE series, offers the user virtually unlimited circuit-building flexibility. The universal matrix of 3,648 solderless, plug-in tie points is comprised of 512 separate 5-tie-point terminals, 32 vertical distribution buses (each with five connected 5-tie-point terminals) plus 4 horizontal buses (each with 18 connected 4-tie-point terminals). These buses may be linked in any combination to provide unique or common functions such as voltage and ground distribution, reset lines, clock lines, shift command, etc.

A·C·E 212
Part No. 923331
$34.95



1,224 SOLDERLESS PLUG-IN TIE POINTS
CAPACITY: *UP TO 12* 14-PIN DIP's
- Two 5-way binding posts
- Size: 4-9/16" by 7"
- Fully assembled

Model 212 is identical with the 201-K kit except that it has more distribution buses for greater flexibility. The universal matrix of 1224 solderless, plug-in tie points consists of 192 separate 5-tie-point terminals, 6 vertical distribution buses (each with 9 connected 4-tie-point terminals) and 2 horizontal distribution buses (each with 6 connected 4-tie-point terminals). Buses can be used for voltage and ground distribution, reset & clock lines, shift command, etc.



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Each kit contains 350 wires cut to 14 different lengths from 0.1" to 5.0'.
Each wire is stripped and the leads are bent 90° for easy insertion.
Wire length is classified by color coding.
All wire is solid tinned 22 gauge with PVC insulation.
The wires come packed in a convenient plastic box.

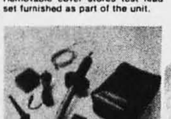
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AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ± 1.0% rdg ± 0.5% f.s. (—2dB max. at 5kHz); Max. input: 600V.
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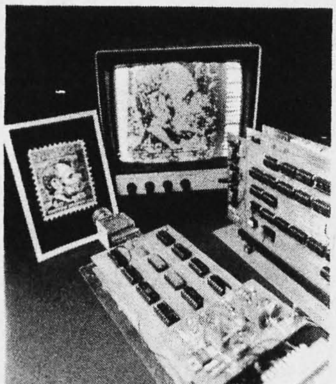
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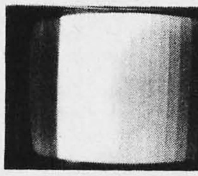
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4010 –	.37	4024 –	.75	4071 –	18	74C160	1.05
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7411 –	.18	7489 –	1.25	74175 –	.85
7412 –	.18	7490 –	.42	74176 –	.75
7413 –	.36	7491 –	.58	74177 –	.75
7414 –	.60	7492 –	.43	74180 –	.65
7416 –	.22	7493 –	.43	74181 –	1.90
7417 –	.25	7494 –	.67	74190 –	1.00
7420 –	.18	7495 –	.65	74191 –	.85
7425 –	.30	7496 –	.65	74192 –	.79
7426 –	.22	7497 –	.90	74193 –	.79
7427 –	.28	74107 –	.28	74194 –	.80
7430 –	.18	74121 –	.30	74195 –	.50
7432 –	.22	74122 –	.40	74196 –	.86
7437 –	.22	74123 –	.45	74197 –	.80
7438 –	.22	74125 –	.40	74279 –	.55
7440 –	.18	74126 –	.40	74298 –	.90
7441 –	.70	74148 –	1.10	74368 –	.62
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74LS00 –	.31	74LS138 –	.94
74LS02 –	.31	74LS139 –	.94
74LS03 –	.31	74LS151 –	.88
74LS04 –	.34	74LS153 –	.88
74LS05 –	.34	74LS155 –	.92
74LS08 –	.34	74LS156 –	.92
74LS09 –	.34	74LS157 –	.92
74LS10 –	.31	74LS160 –	1.21
74LS11 –	.31	74LS161 –	1.21
74LS13 –	.59	74LS162 –	1.21
74LS14 –	1.08	74LS163 –	1.21
74LS15 –	.31	74LS164 –	1.34
74LS20 –	.31	74LS168 –	1.42
74LS21 –	.31	74LS169 –	1.42
74LS22 –	.31	74LS170 –	1.89
74LS26 –	.39	74LS173 –	1.62
74LS27 –	.39	74LS174 –	1.35
74LS28 –	.39	74LS175 –	1.35
74LS30 –	.31	74LS181 –	2.97
74LS32 –	.39	74LS190 –	1.48
74LS37 –	.37	74LS191 –	1.48
74LS38 –	.37	74LS192 –	1.19
74LS40 –	.31	74LS193 –	1.48
74LS42 –	.88	74LS195 –	1.08
74LS47 –	.98	74LS196 –	1.08
74LS51 –	.34	74LS197 –	1.08
74LS54 –	.34	74LS241 –	3.37
74LS73 –	.47	74LS257 –	1.19
74LS75 –	.67	74LS258 –	1.19
74LS76 –	.47	74LS259 –	1.82
74LS86 –	.47	74LS265 –	40
74LS90 –	.67	74LS266 –	53
74LS92 –	.67	74LS279 –	94
74LS93 –	.67	74LS290 –	81
74LS109 –	.47	74LS293 –	.78
74LS112 –	.47	74LS365 –	.81
74LS113 –	.47	74LS366 –	81
74LS114 –	.47	74LS368 –	.81
74LS124 –	1.25	74LS375 –	.94
74LS125 –	.61	74LS386 –	.47
74LS126 –	.61	74LS390 –	196
74LS132 –	.94	74LS670 –	2.70

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LM 301/748	25
LM307 –	.30
LM 308 –	.75
LM 311 –	75
LM 318 –	1.20
LM 324 –	.70
LM 339 –	1.10
LM 358 –	.70
LM 370 –	1.15
LM 377 –	1.60
LM 380 –	.95
LM 382 –	1.25
LM386 –	.80
LM 387	1.25
LM 537 –	2.50
LM 553 –	2.50
LM 555 –	.39
LM 556 –	.85
NE540L –	2.25
560 –	2.00
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566 –	1.10
567 –	1.10
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710 –	.35
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200	.70	1.10	1.75	.60	.70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
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Unclassified Ads

FOR SALE: TI TM990/100M-1 microcomputer board with TIBUG monitor in read only memory, 256 words of programmable memory, TM990/103 microterminal, TM990/511 extender board and all documentation. It is a great little machine. I just don't have time to build a system around it. List price is over $750. It's yours for $550 postage paid. W H Ganoe, 1634 E Drachman, Tucson, AZ 85719.

FOR SALE: Like new 33ASR. Purchased new and seldom used, $850. 101C data set (110 bps modem) very nice, $200. CCU to interface 33ASR with 101C, $100. All three $1,000. Joe Turtle, POB 147, Corunna MI 48817, (517) 743-4607 after 6 PM.

SCHOOL SALE TO RAISE MONEY: Two Mohawk Data Sciences super compact card readers model SCCR 6002 (6 2/3 cards per second), two A B Dick videojet ink-jet printers model 9600 (250 characters per second, with parallel interface). Both appear to be working and are hardly used. Also selling three Micro Systems Inc Micro 810 computers. They are microprogrammable, 220 ns, with teletypewriter interface and a combined total of 16 K core memory. The Berkeley High School Technology Club is selling these to raise money for projects, activities, etc. Any reasonable offer considered. Contact Eric Martinot, 2206 B Jefferson Av, Berkeley CA 94703, (415) 849-2663.

FOR SALE: Heath microprocessor course and trainer. Includes all accessories, instructions, and course examination. $200. A Alberto, 634 Blvd East, Weehawken, NJ 07087, (201) 864-1472.

HELP: For ND-812/BR-2412 users. Is there any existing users group for the ND-812 or BR-2412 minicomputer; or are there any other individual users of these orphaned systems who would like to communicate for mutual support? Write or phone: Bill Hunt, 237 South Blvd, Oak Park IL 60302, (312) 366-0194.

FOR SALE: Altair 8800 microcomputer with 28 K memory; has 3 P+S, cassettes user tape system board, VDM, 16 K read only memory board with monitor, 1 K board for stack, and keyboard. Asking $1400. Larry Belmontes Jr, 1762 Yale St, Corpus Christi TX 78416, (512) 855-2687.

WANTED: Drawings, schematics and pin out data to interface a Sycor Inc. Model 303 Key-Cassette to a microcomputer. Will pay for documentation. Jim Cook, 11451 Olson Dr, Garden Grove CA 92641.

FOR SALE: Prolog read only memory programmer with UV light eraser. Program, copy, read, or edit 1702 UV read only memories. Excellent condition in attache case. Cost $2000. Sell for $640. Bill Fujitsubo, 1506 Sandcastle Dr, Corona del Mar, CA 92625.

FOR TRADE: Texas Instruments Silent 700 portable terminal, model number 725. Perfect working condition and clean. Want to trade for used Decwriter II or video type terminal. Will consider sale outright. Mark Jay Hunt, 3040 Vistamonte Dr, San Jose CA 95118, (408) 265-7799 nights.

FOR SALE: Digital Group Z-80 system; 34 K; four Phidecks; keyboard; monitor; dress cabinets for all; all software (MaxiBASIC, Business BASIC, Assembler, Startrek, Chess, etc). Must sell – any reasonable offer accepted. John Case, 6703 Timberhill, San Antonio TX 78238, (512) 681-7504.

FOR SALE: TV camera parts; 7735A Vidicon tube brand new $30; 16 mm lens $10; deflection and focus coil $18; video amplifier $5; and other miscellaneous goodies. Schematics available. Everything I have for $45 plus shipping. S Stoddard, 12 Kathy Dr, Poquoson VA 23662, (804) 868-7682.

FOR SALE: Disk and tape drivers from GE-115 computer system plus disk packs and other parts. Also Teletype ASR33, $500; Dura Mach-10 needs considerable work or good for parts, $100; Altair 2-SIO board, $100; XY plotter with 10 by 15 inch (25.4 by 38.10 cm) plotting bed, $200; 72 CPS paper tape reader, $25; 3M microfiche viewer/printer, $100. Will consider trades. SASE for more information. Don Bailey, 19 Shaker Rd, Concord NH 03301.

FOR TRADE: 8080 FORTRAN MITS disk version for 8080 COBOL or MITS timesharing BASIC. Manuals included. K R Roberts, 10560 Main St, Suite 515, Fairfax VA 22030, (703) 378-7366, (703) 591-6008, (703) 691-0277.

FOR SALE: January thru December 1978 BYTE (volume 3) complete, mint condition, unopened. These 12 issues are yours for $15 (includes fourth class shipping). Send check or money order to John Burnet, 10324 S Prospect Av, Chicago IL 60643.

FOR SALE: Two Solid State Music 4 K Static programmable memory boards from a working (and lovable) Altair 8800, asking $80 each or both for $150. Also have a working Digital Group TVC-F (video interface and audio cassette too). It lists for $195, but it's yours for $130. Dale Morris, 4334 N Quincy, Kansas City MO 64117.

FOR SALE: Tektronix 535A scope with H wide-band preamp and M 4 trace plug-ins, $400 plus shipping. Tektronix TM503 instrument module enclosure and two blank modules, new, $200. MFE digital cassette drive, model 205, four cassettes with clock track and documentation, $120. J A Titus, POB 242, Blacksburg VA 24060, (703) 951-9030.

FOR SALE: Three S D Sales 4 K static programmable memory boards, fully operational, with all documentation. 500 ns access, data read at PDBIN! All three shipped promptly for certified funds of $180 (that's less than 1.5¢ per bit!). W Howard Adams, 1590 S Krameria St, Denver CO 80224, (303) 756-4052.

KIM USERS: Powerful console input monitor (CIM) lets you enter, edit, and execute programs from ASCII encoded keyboard on BASIC KIM. CIM modes are: address, program, text, data, increment, decrement, and execute. Complete documentation included for $16.50 postage paid. Add $5 for CIM cassette. E R Kittlaus, POB 2175, Seal Beach, CA 90740.

FOR SALE: BYTE issue numbers 1 thru 16 in mint condition for best offer. Dave Babcock, 107 SE Jay, Pendleton OR 97801.

FOR SALE: Panasonic 8½ inch diagonal black and white video monitor with UHF type connectors. $50 or best offer. Charles Baumer, 5055 W Drummond Pl, Chicago IL 60639, (312) 637-0414.

HALF PRICE SALE: Factory wired IMSAI 8048 Control Computer with 2 K programmable memory installed. New condition, runs perfectly, fully documented. $190 via UPS. H A Chinn, 757 Bolanos Ct, Port Charlotte FL 33952, (813) 625-2032.

FOR SALE: Partially assembled SwTPC CT-64 terminal kit. Keyboard and video terminal completed and working with sockets for all integrated circuits. $250. Allan J Hogue, RR 2, Norwalk IA 50211, (515) 462-3220.

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Readers who have equipment, software or other items to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement must be clearly noncommercial, typed double spaced on plain white paper, contain 75 words or less, and include complete name and address information.

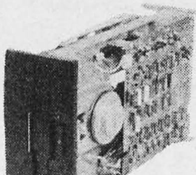
These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

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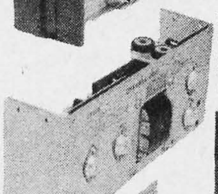
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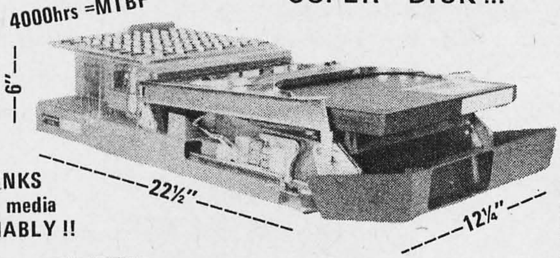
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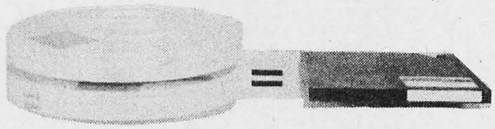
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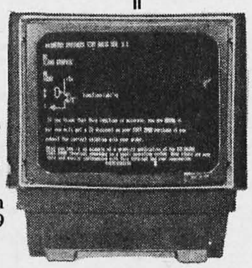
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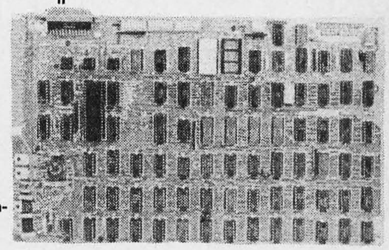
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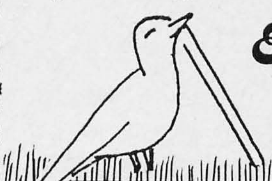


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Early-Bird Specials...

Daisy Wheel Printers

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- Model 5541 (IBM Correspondence code) $695.00
- Model 5550 (corres. code, built-in cassette drive) $1195.00
- Model 5560 (ASCII code, built-in cassette drive) $1295.00

•**IBM SELECTRIC 725 TYPEWRITER I/O** w/solenoids switches & magnet driver PCB (from GTE/IS terminal) plus instructions for 8080 printer-driver interface hardware & software.

- a) Typewriter mechanism complete, cleaned & adjusted $375.00
- b) Case from terminal & power supply(+24V, ±12V, +5V @5A). . $ 75.00
- c) a & b plus output ASCII interface to mCPU 8-bit parallel port . $650.00

•**POS 103/202 *"MIX or MATCH"* MODEM:** BELL 103 and/or BELL 202 FREQUENCIES: Unique POS control design permits use in one housing of both Bell-compatible 103 (0 – 300 baud) and 202 (0 – 1200 baud) modem modules originally made by VADIC Corp. for a telephone company subsidiary. FEATURES: RS-232 serial interface, auto-answer, auto-dial, LED display, telephone line interface via acoustic coupler, manual DAA, or auto-answer DAA (sold separately.) FULLY ADJUSTED; no special tools required. 3,000 mile range over standard dial-up telephone lines.

- –POS 103 MODEM (with Auto Answer, Auto Dial). $179.95
- –POS 202 MODEM (Half-Duplex with Reverse Channel). $249.95
- –POS 202 MODEM (Half-Duplex w/Rev. Ch., Auto-Answer) $279.95
- –POS 103/202 MODEM (Auto-Answer, Auto-Dial). $399.95

•**DIABLO HYTYPE I Model 1200 Printer Mechanism:** used, complete and operational. Requires power supply, case & mCPU interface. 15 day return privilege – no other warranties. LIMITED QUANTITY! $750.00

- –6' Ribbon cable & connector for printer Main Logic PCB $10.00
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- –"As-is" spare printer PCB's for parts (Logic, Heat Sink, Control): ea. $20.00

•**NEW TAPE DRIVE CONTROLLER for Microcomputer:** POS Version II tape drive controller is now available, permitting the 8080 or Z-80 owner to read **and** write standard IBM NRZ1 format tapes (as well as ASCII tapes) with the Ampex Model TMX tape drive described below. Controller is sold only with tape drive, comes complete with connector cables to CPU and software listing in 8080 assembly language (specify 2MHz or 4MHz system.)

- –Ampex TMX tape drive (used) with Version II Controller $1500.00

•**AMPEX MODEL TMX TAPE DRIVE:** Ideal for microcomputerist who wants backup mass storage or access to IBM-type systems via standardized 2400 series ½" mag tape. Specs: 9-track, NRZ1 standard, 800 BPI, 12"/sec., 1200 ft. reels (11 megabyte capacity.) Drive is like new & comes with 8-bit CPU controller diagram (requires only 11 I/C's) & mCPU interface instructions:

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•**DIGITAL CASSETTE DRIVE** (from GTE/IS Terminal): 1800 baud, 6"/sec; AC motor; fwd/rewnd circuitry plus tape head, no read/write electronics $25.

•**FORMS TRACTORS,** Moore Variable width "Form A-Liner" for print terminals:

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- b) Model K81 for QUME or DIABLO Hytype I or II printers (new): $90.00

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Innovations and Home Security Top BOMB Scores

The January 1979 BOMB put a variety of topics at the top of our list. The first place prize of $100 goes to Joel Boney and Terry Ritter for "A Microprocessor for the Revolution: The 6809" (page 14). The second place prize of $50 went to Steve Ciarcia for "Build a Computer Controlled Security System for Your Home, Part 1 (page 56).

The third place article was "History of Computers: The IBM 704," by Keith Reid-Green (page 190). Fourth place was Part 4 of "Creating a Chess Player," by Peter Frey and Larry Atkin (page 126).■

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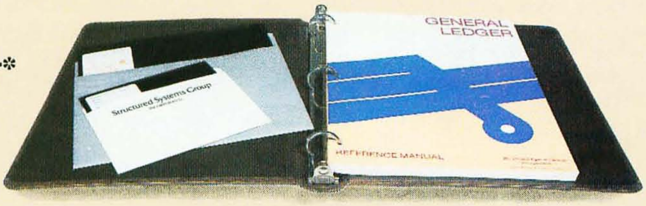
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